N00101.AR.002758
NAS SOUTH WEYMOUTH
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FEASIBILITY STUDY REPORT FOR BUILDING 82 NAS SOUTH WEYMOUTH MA
7/1/2012
TETRA TECH

Feasibility Study Report
for
Building 82

Naval Air Station South Weymouth
Weymouth, Massachusetts

Naval Facilities Engineering Command
Mid-Atlantic

Contract Number N62470-08-D-1001

Contract Task Order WE11

July 2012

080904/P

FEASIBILITY STUDY REPORT

FOR

BUILDING 82

NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Mid-Atlantic
9742 Maryland Avenue
Norfolk, Virginia 23511-3095

Submitted by:
Tetra Tech
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

CONTRACT NUMBER N62470-08-D-1001
CONTRACT TASK ORDER WE11

JULY 2012

PREPARED UNDER THE DIRECTION OF:

Phoebe A. Call

PHOEBE A. CALL
PROJECT MANAGER
TETRA TECH
WILMINGTON, MASSACHUSETTS

APPROVED FOR SUBMISSION BY:

John Trepanowski

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH
KING OF PRUSSIA, PENNSYLVANIA

NAVY RESPONSES TO U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) COMMENTS DATED JUNE 19, 2012 & JUNE 28, 2012 REVISED DRAFT FINAL FEASIBILITY STUDY – BUILDING 82 FORMER NAVAL AIR STATION (NAS) SOUTH WEYMOUTH, MASSACHUSETTS

Responses to the EPA comments on the Navy's May 30, 2012 Responses to Comments (RTCs) on the Revised Draft Final Feasibility Study for Building 82 are presented below. The EPA comments are presented first (in italics) followed by Navy's responses.

EPA Comments dated June 19, 2012. *EPA has reviewed the RTCs for the Rvsd Draft Final FS (excluding ARARs-related issues) and offers the following:*

Comment 1. Page 4-12, §4.2.2.2 *- The Navy's response appears to contradict the text on page 4-9 which states that there is an impact on the microbes; the text on page 4-12 should be edited to resolve the apparent contradiction.*

Response: [Note that the above comment refers to the original EPA page-specific comment #20.] The text on page 4-9 states that ISCO "may impact the existing bacterial community," however the text also notes that the bacterial community in the area downgradient of the ISCO injections will not be affected. For clarification the text on page 4-12 has been revised as follows: "No adverse short-term or cross media effects are anticipated as a result of implementation this alternative. However there may be impacts on the bacterial community in the immediate area of the ISCO injections."

Comment 2. Page 4-22, §4.2.4.1 *- Please clarify that short-term monitoring will be detailed in the remedial design, since Navy does not intend to discuss it in the long-term monitoring plan.*

Response: [Note that the above comment refers to the original EPA page-specific comment #27.] The following sentence has been added at the end of the partial paragraph at the top of page 4-22: "Details for the short-term performance monitoring will be determined as part of the remedial design."

Comment 3. Page 4-23, §4.2.4.1 *- Please add "Arsenic" to the last paragraph of the response and include it in the FS text.*

Response: [Note that the above comment refers to the original EPA page-specific comment #28.] Agreed. The baseline sampling event will include manganese, arsenic, MTBE, and PCB analyses.

Comment 4. Attachment to EPA RTCs: *As discussed at last week's BCT meeting, the input toxicity factors for TCE in the Johnson & Ettinger (J&E) Model are incorrect. As an example, the copy of the Chemical Properties Lookup Table indicates that the unit risk is 1E-06 and the Reference Concentration is 0. Please provide J&E output documentation that shows that the correct toxicity factors are used and confirm that the model results continue to support the conclusion that vapor intrusion is not an issue.*

Response: Because TCE has IURs for both mutagenic and non-mutagenic effects the cancer risks for TCE have to be calculated twice. The RfC value is included on the non-mutagenic spreadsheets for TCE and therefore the RfC values on the pages referenced above and questioned by R. Sugatt at the June 14th BCT meeting are listed as "0" or NA (these are pages for TCE mutagenic effects). They are left off of the mutagenic spreadsheets because the risks from both spreadsheets are summed and we did not want to double count the non-carcinogenic risks. For calculating a PRG, one sums the reciprocals; for calculating cancer risks, one sums the cancer risks. In either case both the mutagenic and non-mutagenic effects are taken into account, and the calculation of the PRG appears at the end of the second spreadsheet. The PRG for non-mutagenic effects is lower than that for mutagenic effects. If the PRG for non-mutagenic effects is used alone the mutagenic effects would be ignored. In conclusion, the calculations used the current toxicity factors and no further J&E output documentation is required.

Comment 5. *Consistent with SRA FS language, please change all references to "prohibit the installation of extraction wells for drinking water and irrigation" to "prohibit the installation of groundwater production, supply or irrigation wells."*

Response: Agreed, LUC references throughout the FS have been changed as noted in the comment.

EPA Comments dated June 28, 2012. *EPA's comments on the revised ARARs tables:*

Comment 1. *Table 4-2, Table 4-8, and Table 4-11 - Revision acceptable.*

Response: Noted.

Comment 2. *Table 4-4 and Tables 4-5 through 4-7, Table 4-10, and Table 4-13- (1) RCRA-related ARAR - Response acceptable, (2) CAA-related ARAR - Response unacceptable, ARAR is applicable (see Sept. 2007, Ottati & Goss ROD); please add to tables. (3) VI ARAR - Response acceptable.*

Response: Noted. The NESHAPs ARAR has been added to the action-specific ARARs Tables 4-4, 4-7, 4-10 and 4-13.

NAVY RESPONSES TO MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (MASSDEP) COMMENTS DATED JUNE 4, 2012
REVISED DRAFT FINAL FEASIBILITY STUDY – BUILDING 82
FORMER NAVAL AIR STATION (NAS) SOUTH WEYMOUTH, MASSACHUSETTS

Responses to the MassDEP comments on the Navy's May 30, 2012 Responses to Comments (RTCs) on the Revised Draft Final Feasibility Study for Building 82 are presented below. MassDEP's comments are presented first (in italics) followed by Navy's responses.

Comment 1: *Responses to DEP comments are acceptable; however, regarding the response to Comment 2, Second Bullet: the cited statement in the second paragraph conflicts with the first paragraph ("...only one inspection would be performed."). Consequently, the conflicting text in the first paragraph should be corrected.*

Response: Please note that consistent with the May 30, 2012 responses to EPA comments on the Revised Draft Final FS, the sentence in the second paragraph: "Because the treatment time is expected to be one year, only one inspection would be performed" has been deleted and the referenced paragraph now reads: "Annual inspections of the site would be conducted to confirm compliance with the LUC objectives, and annual compliance certificates would be prepared and provided to USEPA and MassDEP. Prior to any property conveyance, USEPA and MassDEP would be notified."

The original response to DEP Comment 2, second bullet should have referred to the first sentence of the third paragraph.

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ABBREVIATIONS AND ACRONYMS

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	Below ground surface
BRAC	Base Realignment and Closure Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH_4	Methane
cis-1,2-DCE	cis-1,2-Dichloroethene
CLEAN	Comprehensive Long-Term Environmental Action Navy (contract)
CMR	Code of Massachusetts Regulations
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COC	Contaminant of concern
COI	Compound of interest
COPC	Contaminant of potential concern
CSF	Cancer slope factor
CSGWPP	Comprehensive State Groundwater Protection Program
CTE	Central tendency exposure
CTO	Contract Task Order
CWA	Clean Water Act
DCA	Dichloroethane
DHC	*Dehalococcoides*
DO	Dissolved oxygen
DOD	Department of Defense
DPT	Direct push technology
EBS	Environmental Baseline Survey
EFANE	NAVFAC Engineering Facilities Northeast
EOS	Emulsified oil substrate
EPC	Exposure point concentration
EPH	Extractable petroleum hydrocarbons
ERA	Ecological risk assessment
FDS	Floor drain system
FS	Feasibility Study
ft^2	Square feet
GHG	Greenhouse gas

GRA	General response action
GTM	Gas trap manhole
HHRA	Human health risk assessment
HI	Hazard index
ILCR	Incremental lifetime cancer risk
IR	Installation Restoration
ISCO	In-situ chemical oxidation
LUC	Land use control
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCP	Massachusetts Contingency Plan
mg/kg	Milligram per kilogram
MMBTU	Million British thermal Unit
MNA	Monitored natural attenuation
MTBE	Methyl tert-butyl ether
N_2O	Nitrous oxide
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NERP	Navy Environmental Restoration Program
NNPA	N-nitroso-di-n-propylamine
NO_x	Nitrogen oxide
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and maintenance
ORC	Oxygen-release compound
ORP	Oxygen reduction potential
OSHA	Occupational Safety and Health Act
OWS	Oil-water separator
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PDWSA	Potential Drinking Water Source Area
PM_{10}	Particulate matter less than 10 micrometers in diameter
PPA	Potentially Productive Aquifer
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal

RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference dose
RI	Remedial Investigation
RIA	Review Item Area
RME	Reasonable maximum exposure
ROD	Record of Decision
RSL	Regional Screening Level
SO_x	Sulfur oxides
SVOC	Semivolatile organic compound
TACAN	Tactical Air Navigation
TAL	Target Analyte List
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TOC	Total organic carbon
TtNUS	Tetra Tech NUS, Inc.
UPL	Upper prediction limit
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile organic compound
VPH	Volatile petroleum hydrocarbons
µg/L	Microgram per liter

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

1.1.1 Purpose

This Feasibility Study (FS) was prepared for the Building 82 Site (the Site), located at Naval Air Station (NAS) South Weymouth, in Weymouth, Massachusetts (the Base), in accordance with Contract Task Order (CTO) WE11 under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62470-08-D-1001. The document was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is consistent with the United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (1988) and the Navy Environmental Restoration Program (NERP) Manual, Chapter 8, Remedial Investigation/Feasibility Study (Navy, 2006). This FS Report describes the formulation and evaluation of remedial alternatives for contaminated groundwater at the Site. The FS establishes Remedial Action Objectives (RAOs) and cleanup goals; screens remedial technologies; and assembles, evaluates, and compares remedial alternatives. The FS was based on data collected during previous investigations, specifically a series of Remedial Investigations (RIs) conducted from 2005 through 2010. Those investigations culminated in the completion of the RI report for the Site (TtNUS, 2010), an RI Addendum (TtNUS, 2011) and comments from USEPA and the Massachusetts Department of Environmental Protection (MassDEP) on the RI and draft FS Report. The RI evaluated contaminant nature, extent, fate and transport, and calculated the potential risks to human health and the environment that are associated with exposure to those contaminants.

The purpose of the FS is to gather and evaluate information sufficient to develop and evaluate a range of remedial alternatives to mitigate potential risks to human health resulting from past Navy activities at the Site. Within an FS report, the results of an RI are used to develop and evaluate potential remedial alternatives that permanently and significantly reduce the risks to human health and the environment identified at the Site. The alternatives must meet protectiveness standards and meet all ARARs, as required under the USEPA's National Contingency Plan (NCP), provide the best balance of the remaining NCP criteria to mitigate the identified risks, and the range of alternatives should be adequate so that consensus can be reached between the Navy and regulators regarding the selected response action.

Subsequent to the FS, the Navy will present the preferred remedial alternative in a Proposed Plan for public comment. Following a 30-day public comment review period, the Navy will select the remedial alternative(s) and will seek concurrence of the USEPA and the MassDEP. The final remedial alternative(s) will be presented in a Record of Decision (ROD).

1.1.2 Document Organization

This document has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (USEPA, 1988). The report is divided into the following sections:

- Section 1.0, Introduction, summarizes the purpose of the report, provides site background information, summarizes the findings of the RI, and provides the report outline.

- Section 2.0, Remedial Action Objectives and General Response Actions, presents the RAOs, identifies Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria, develops groundwater cleanup goals and associated General Response Actions (GRAs), and provides estimates of the volumes of contaminated media to be remediated.

- Section 3.0, Screening of Remediation Technologies and Process Options, provides a two-tiered screening of potentially applicable soil and groundwater remediation technologies and identifies the technologies that were assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives, assembles the remedial technologies retained from the Section 3.0 screening process into multiple soil and groundwater remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance with seven of the nine remedy selection criteria set forth in 40 Code of Federal Regulations (CFR) Part 300.430 of USEPA's NCP.

- Section 5.0, Comparative Analysis of Remedial Alternatives, compares the groundwater remedial alternatives on a criterion-by-criterion basis for each of the seven CERCLA analysis criteria used in Section 4.

1.2 SITE BACKGROUND

The following paragraphs provide background information about the Site. Figure 1-1 provides the general location map and Figure 1-2 shows general features of the site.

1.2.1 Site Description

The former NAS South Weymouth is comprised of approximately 1,440 acres located 20 miles southeast of Boston in the Towns of Weymouth, Abington, and Rockland, Massachusetts. The Site is located in the middle portion of NAS South Weymouth (Figure 1-1), between Aircraft Taxiway No. 2, Trotter Road and Shea Memorial Drive (Figure 1-2), within the Town of Weymouth.

This section presents background information on the Base and the Building 82 Site, including Base history, study area setting, and site description and history.

1.2.1.1 NAS South Weymouth

The Base is located primarily in the Town of Weymouth, Norfolk County, Massachusetts. Portions of the Base also extend into the adjacent Towns of Abington and Rockland, Massachusetts; the Town of Hingham forms the northeast boundary of the Base. The Base is located in an urban area, with primary access from Route 18 in Weymouth.

NAS South Weymouth was commissioned during the 1940s to support dirigible aircraft used to patrol the North Atlantic during World War II. The facility was closed in 1949 and then reopened in 1953 as a naval air station for aviation training. NAS South Weymouth was designated for closure under the Base Realignment and Closure Act of 1990 (BRAC), as part of the BRAC Commission's 1995 Base Closure List (BRAC IV). In September 1996, operational closure of NAS South Weymouth began with the transfer of aircraft to other Navy facilities, and through personnel reduction. Between 1996 and 1997, NAS South Weymouth provided facilities for limited ground training to Marine and Naval reserve units (EA, 1998). NAS South Weymouth was closed administratively under BRAC on September 30, 1997. Because of the closure, the facility was placed in caretaker status under the supervision of NAVFAC Engineering Facilities Northeast (EFANE) and is currently under the supervision of the BRAC Program Management Office (PMO) Northeast. Several parcels have been transferred from the Navy to the local reuse authority. Discussions regarding property transfer and reuse are ongoing.

As part of the Base closure, the Environmental Baseline Survey (EBS) investigations were conducted to support the Navy's compliance with: the CERCLA Section 120, as amended by Public Law 102-426; the Community Environmental Response Facilitation Act; and state and local real property transfer disclosure notification regulations. In other words, the EBS investigations were conducted to support environmental restoration programs, Base closure, and property transfers/leases. Phase I EBS investigations were conducted in October and November 1995, for those areas of the Base property not already addressed by the DOD Installation Restoration (IR) or Massachusetts Contingency Plan (MCP) programs (MassDEP, 1996). They included visual inspections of all Base property and adjoining property, records reviews, and interviews. The information collected during the Phase I EBS investigations was used to identify specific areas of potential concern and to recommend the level of further investigation required at each of these locations. Areas identified in the Phase I EBS Report (issued in November 1996) as requiring additional investigation were designated as Phase II EBS Review Item Areas (RIAs). Based on the Phase II EBS investigations, RIAs where analytical results of environmental samples indicated concentrations of chemicals exceeding screening criteria were designated as Areas of Concern (AOCs). AOCs were then investigated under CERCLA.

During the Phase I EBS, the NAS South Weymouth Fire Department Spill Response records were reviewed; the records indicated that spills associated with aircraft refueling and maintenance occurred on the Building 82 apron, close to the hangar. Fire Department personnel indicated that the regular practice for spills on runways and taxiways was to wash the spilled material into the adjacent grassy areas. Many of the investigations that followed the Phase I EBS, and that involved what is now the Building 82 site, were conducted under specific RIAs and AOCs. These investigations are discussed in Section 1.2.2. Based on the results of these investigations, it was recommended that additional investigation of the Building 82 Site be conducted under CERCLA, as part of the IR program.

Primary data gathering efforts for the Site have been a comprehensive field study: (1) an initial Phase I RI, which was implemented in 2005; (2) a Phase II RI, which was conducted in 2006; and (3) a supplemental RI investigation conducted in 2009 through 2010.

1.2.1.2 Building 82 (IR Site 10)

Building 82 (also referred to as Hangar 2) is located in the middle portion of the Base, between Aircraft Taxiway No. 2, Trotter Road and Shea Memorial Drive. It is approximately 4,500 feet southeast of the main entrance to the Base on Route 18. The land areas associated with the Building 82 Site that are not occupied by the building footprint consist primarily of paved areas, with patches of maintained lawns and successional grassland and shrubland. Forested and shrub wetlands are also present in the vicinity of Building 82, but are separated from the building by a significant border of pavement, which extends more than 100 feet beyond the building in most directions. The Site covers an area of approximately 10 acres.

A former aircraft hangar, Building 82 was constructed in 1956 as an aircraft hangar (maintenance facility) for fixed wing aircraft. It was continuously used by the United States Marine Corps for that purpose from 1956 through 1996, when operations at the Base ceased. During that time, oils, lubricants, and solvents necessary for aircraft maintenance were used and stored in the building. Following Base closure, Building 82 was used for the storage of miscellaneous Navy-owned vehicles (i.e., plows, backhoes, buses, etc.) until 2000. Building 82 is currently vacant; however, the building may be occasionally occupied by Navy personnel during routine building maintenance inspections.

Building 82 is comprised of two main areas, the aircraft hangar and the shop/office area. The aircraft hangar, located in the eastern portion of the building, is a large open area occupying the full height of the hangar building and was used for aircraft maintenance and storage. The shop/office area, located in the western portion of the building, consists of a main level, mezzanines, and an upper level, each of which was subdivided into numerous smaller rooms or shops for particular operations. During its use, the main level housed several specific light industrial operations. The engineering drawings of the building indicate that the main level included a carburetor shop, plating shop, paint and dope shop, weld shop, machine shop, structures and hydraulics shop, engine shop, ordnance shop, radio shop, radar shop, electric shop, battery locker, and small arms stores. The mezzanines, which are located above portions of the shop area to the north, west, and south, consisted of office space, a motor generator room, and two transformer switch rooms. The upper level of the shop/office area consisted of office space and classrooms.

In addition to these operational areas, there was a complex network of subsurface drainage structures and pre-construction features underneath the building. Many of these features are presumed to still exist, while other features have been altered or removed during Base decommissioning activities. For example, most of the subsurface drainage pipelines were either plugged or excavated in 1998, 2000, and 2006, as part of an overall Base decommissioning effort implemented by the Navy to position the property for transfer and re-use. Additional information on site features, including previous utilities and floor drain systems, as well as modifications to these features, is presented in the subsections that follow.

Based on the RI Addendum investigations, the area east of the Building 82 southern apron has been added as a potential source area and is comprised of Building 15, Building 41, and the paved areas surrounding them. This is described further in Section 1.3.1.

Pre-Existing Site Features

Prior to construction of Building 82, a roadway with a north-south alignment was located within the area now occupied by the hangar portion of the building. Along the road right-of-way were several utilities including water, storm drain, electrical and communication lines, sanitary sewer, sprinkler pipe, and a jet fuel pipeline. As-built drawings show these utilities were rerouted around the building when it was constructed, and remaining features were abandoned or salvaged. All pipelines were salvaged. There were also two drainage ditches: one in a north-south alignment from Houghton Street which passed under the shop/office part of the building (Ditch 1), and the other in a northwest-southeast alignment (Ditch 2) that merged with Ditch 1 near the southwest corner of the building. The elevations of these utilities and ditches are not known; however, it can be inferred from the engineering drawings that they likely ranged from 6 to 8 feet below grade.

As-Built Drainage Features: Drainage Ditches and Floor Drainage System

The surface water drainage pattern was substantially changed for the construction of Building 82. Drainage Ditch 1 from Houghton Street was rerouted through pipes to the existing ditch about 300 feet north of Building 82. This ditch currently drains into two 42-inch storm sewers which pass under the Site just west of Building 82 and discharge into an existing ditch about 250 feet south of the building. Drainage Ditch 2 was replaced with a new ditch located between the Site and Taxiway No. 2 to the west, and Trotter Road to the south. This existing ditch carries most of the Site drainage and empties into the same ditch that receives the discharge from the two 42-inch storm sewers. It is assumed that Ditches 1 and 2 were filled during construction of the building.

Building 82 was constructed with 17 floor drains (see Figure 1-3). Twelve large floor drains were located in the hangar portion of the building. The remaining five drains were located in the shop/office area of the building. The hangar floor drains discharged into four parallel cast-iron pipes [Floor Drain System (FDS)-I, II, III, and IV] that began in the hangar area and flowed from east to west to gas-trap manholes located just outside the west wall of the building. Drainage from trenches located beneath the large hangar doors on the north and south sides of the building also discharged into the hangar floor drain system through six lateral cast-iron pipes of 6-inch diameter. The four hangar drainage lines began with a 10-inch diameter pipe and stepped up in diameter at the confluence of each floor drain, to 12 inches, then to 15 inches, before they entered the gas trap manholes. The floor drainage from each of the gas-trap manholes was connected to one of the 42-inch storm sewers, described in the previous paragraph, through short 15-inch diameter cast-iron connector pipes.

The six drains located in the shop/office area of the building are independent of the hangar floor drain system. Of the six drains in the shop/office area of the building, D5 was connected to the sanitary sewer. The other five drains, D1, D2, D3, D4, and D6, were routed through pipes to discharge into one of the two 42-inch storm sewers. Drain D1 consisted of three floor drains and one spray-booth drain located in the carburetor/pump testing shop, the paint and dope shop, and the plating shop located in the northwest corner of the building. The paint-booth drain was located in the paint shop. This system was connected to a 3-inch pipe that exited the building and discharged into an 8-inch storm sewer before discharging into one of the 42-inch storm sewers via gas-trap manhole 1 (GTM-1). Drain D2 was made up of inlets from a tank spray-booth and degreaser unit located in the machine shop area. These two drains joined one of the sub-floor 8-inch roof drain lines, which discharged directly into one of the 42-inch storm sewers. Drain D3, located in the engine shop area, joined another 8-inch roof drain line, which discharged directly into one of the two 42-inch storm sewers. Drain D4 was located in the battery locker room along the south side of the building and drained into a 3-inch line that exited the building and joined an 8-inch storm sewer along the south side of the building before discharging directly into one of the 42-inch storm sewers. Drain D6, located in the electric/radio shop and found to be connected to a sump pump, joined another

8-inch roof drain line, which discharged directly into one of the two 42-inch storm sewers. During the removal of drain D6, two pieces of pipe were left in place due to engineering concerns.

<u>Pollution Abatement Modifications to the Floor Drainage System</u>

Plans prepared in 1977 show modifications to the floor drainage system to connect some floor drain features to the sanitary sewer system as part of a pollution abatement project. The four gas trap manholes were connected by a new 4-inch line to intercept the floor drainage, pass it through an oil-water separator unit, and then connect it to an existing 5-inch sanitary sewer line just south of the building. Other modifications disconnected drain D1 (carburetor/pump testing shop, paint and dope shop, and plating shop) and D4 (drain from the battery locker area) from the storm sewer system and connected them to the sanitary sewer system. Lines that had connected D1 and D4 to the storm sewer systems were either abandoned or plugged. Drains D2 and D3 remained connected to the storm sewer system and D5 remained connected to the sanitary sewer system. The 1977 plans indicated that each of the 15-inch lines that connected the gas trap manholes to the 42-inch storm sewers were plugged in order to force all floor drainage into the new sanitary sewer line. However, during an inspection in 1998, it was discovered that these lines were not plugged (Foster Wheeler Corporation, 1999). Therefore, it is possible that even after the 1977 pollution abatement project, floor drainage may have continued to enter the storm sewer system. Almost all sections of the drainage system were either plugged or removed in 1998, 2000, and 2006, as part of Base decommissioning activities.

The historical investigations and removal activities performed at the Site, including decommissioning activities that affected the nature and configuration of the subsurface structures and features underlying Building 82, are summarized below.

1.2.2 <u>Site Investigations and Removal Actions</u>

Prior to or during implementation of this FS, several environmental studies and removal actions were conducted under CERCLA authority for Building 82, which were presented in detail in various reports. Key reports containing Site information are:

- Removal Action Report for Building 82 (Hangar 2), Foster Wheeler Environmental Corporation, March 1999 - In September 1998, a removal action was conducted as part of Base closure activities. Activities included emptying and cleaning the four interior floor drain systems and the four gas trap manholes, and disassembling, cleaning, and removing an oil-water separator (OWS).

- Removal Action Report for Floor Drain System Removals, Hangar 2 (Building 82), Foster Wheeler, April 2001 - Between June and September 2000, a second removal action was conducted to remove the four floor drain systems and assess soil conditions beneath the drainage pipes in Building.

- Draft Closeout Report for Review Item Area 61, TACAN Outfall Excavation, Storm Water Drainage System Cleaning and Associated Ditch/Swale Excavation, TtFW, July, 2004 - The drainage ditch located west and south of Building 82 was investigated and addressed as a component of the NTCRA conducted for AOC 61 in November and December of 2002.

- Final Removal Action Report for Floor Drain Removal Activities (Hangar 2), TtEC, February 2007 - Between April and June 2006 a removal action was conducted to remove six distinct floor drain systems from the interior of the shop/office area in Hangar 2 and to assess soil conditions beneath each system.

- Phase I Initial Site Investigation Report, Building 82 Site, TtNUS, February 2000 - Based on soil data obtained during the 1998 removal action, the MassDEP was notified of site conditions and a Phase I Site Investigation was conducted at the Site. As part of the Phase I Site Investigation, additional field activities were conducted at the Site by ENSR (under contract to TtNUS) in June and July of 1999 to further define the nature and extent of contamination.

- Final Phase II Environmental Baseline Survey Decision Document for Review Item Area 30A, Spills on Hangar 2 Apron, Stone & Webster, December 2002 - The Phase II EBS obtained data for various RIAs to assess environmental conditions and determine whether additional actions were needed. Results of the Phase II EBS were used to produce a Decision Document for RIA 30A, "Spills on Hangar 2 Apron".

- Limited Due Diligence Assessment, Building 82, ENSR, June 2003 - In April and May 2003, ENSR performed a Limited Due Diligence Assessment to provide preliminary environmental data for the developer of the NAS South Weymouth property.

- Access Road Excavation, Environmental Partners, September 2007 – The western side of the grassy area north of the site was excavated during construction of an access road. Soils were screened for VOCs and removed if concentrations were above the RCS-1 criteria. Soils meeting geotechnical and environmental criteria were returned to the excavation.

- Remedial Investigation, Building 82, TtNUS, February 2010 – The RI described the investigations and data evaluation activities conducted in order to assess the nature, extent, fate, and risk associated with contamination in soil, groundwater, surface water, and sediment at Building 82.

- Remedial Investigation Addendum, Building 82, TtNUS, July 2011 – A supplemental investigation was performed to further delineate the extent of contamination of the shallow and deep dissolved-phase trichloroethene (TCE) plumes.

- Maintenance Action and Additional Investigation, TtEC, August 2011 – A maintenance action was performed in accordance with the scope agreed upon by the Navy, EPA and MassDEP. The work included: completion of soil borings and soil sample collection; limited soil excavation in two areas; and removal GTMs and associated piping followed by excavation of impacted soil. Confirmatory soil samples were collected from each excavation area.

1.2.3 Surface Water Hydrology

Surface runoff from the building and its concrete apron flows into catch basins located at the outer edges of the apron that discharge into the drainage ditches along perimeter of the Site. The ditches discharge into the Base's storm drainage system, which flows to the Tactical Air Navigation (TACAN) outfall and ultimately into French Stream. Runoff in the area east of the Building 82 southern apron is directed to the storm drain system via catch basins that connect to the storm drains and eventually to the outfall south of the Hangar 2 apron. Most of the surface water runoff from the center of Building 15 west to the Building 82 drainage ditches appears to drain into the outfall. Storm drains and catch basins in the vicinity of Building 15 are situated primarily above the water table.

1.2.4 Ecological Setting

The Site includes the unoccupied Hangar 2 building and associated paved surfaces; the storm sewer system; two open drainage ditches; and the unpaved grassy area located adjacent to the ditches, outside of the paved sections. In general, the ecological habitat in the immediate vicinity of the Building is limited by the extensive pavement and urbanization. A limited upland successional community occurs in the non-paved grassy portion of the area near Building 82. The majority of vegetation in this area is grassland and old-field community. No federally protected species are expected to live on the Site, however, it is possible that bald eagles and peregrine falcons could occasionally be observed. No potential vernal pool habitat, as defined in the Massachusetts Wetlands Protection Act (M.G.L. c. 141s. 40) and its implementing regulations (310 CMR 10.00), is present at the Site.

1.2.5 Geology

Three general geologic units have been identified at the Building 82 Site: fill (artificially placed), native overburden, and bedrock. Geologic cross sections are provided in Figures 1-4 through 1-8. Additional geologic cross-sections are discussed in Section 3.3.2 of the RI report. The Site overburden, including the fill layer, consists of approximately 25 to 40 feet of unconsolidated materials. Fill material of various types was either imported from off-Base or relocated from elsewhere on the Base. Sandy fill material was observed in areas throughout the Building 82 Site, with a thickness ranging from 0 to approximately 16 feet below ground surface (bgs). The native overburden materials consist predominately of sand and gravel with varying amounts of silt. Overburden deposits have been grouped into three geologic units (sand and silt, sand and gravel, and glacial till) based on boring log descriptions. In general, the native overburden units described below are listed according to the depth at which they occur (shallow to deep), however not all units are present at each boring location and fill overlies the native units in some areas. The native overburden units can be classified as follows:

Sand and Silt – Fine-to-coarse sand, silty sand, and silt are present within the overburden in thicknesses ranging from 0 to approximately 35 feet. A lack of gravel in this unit was used to help distinguish it from the overlying sandy fill (where present) and the sand and gravel unit. Some of these materials may have been glaciolacustrine in origin, some deposited in glacial meltwater lakes and ponds.

Sand and Gravel – This unit is identified by well-graded sands (fine to coarse) and gravels with trace amounts of silt and clay; it is interpreted to have been deposited by glacial meltwaters. This unit is predominant in borings in the north-central part of the Base, including the Building 82 Site, and ranges from 0 to approximately 14 feet in thickness.

Glacial Till – Glacial till deposits are unstratified, and widely heterogeneous in their grain-size distribution, potentially including clay size to boulder size materials. According to the Building 82 boring logs, a unit comprised of sand, silt, and gravel with varying amounts of clay and rock fragments is interpreted as till based on composition and relatively higher density. This unit ranges from 8 to 40 feet in thickness. As previously stated, two types of till have been described basewide: a sandy upper till and a more compact lower till, characterized by less sand and a higher percentage of silt and clay. The unit is described on the geologic cross sections as “sand, silt, and gravel (potential till)” to be consistent with the physical descriptions on the boring logs and the interpretation provided here. In general, glacial till found on the Base is predominately gray in color, in contrast to fill material which is predominantly tan or brown.

Bedrock core samples indicate the Site is underlain by Dedham Granite. The granite is weathered, fractured, medium to coarse-grained, and light grayish-pink to greenish-gray in color. Bedrock elevation measurements indicate the bedrock surface dips to the southwest and southeast into a trough located in the vicinity of the 42-inch storm sewers on the west side of Building 82.

1.2.6 Hydrogeology

Although the general direction of overburden groundwater flow at the Base is toward the southwest, groundwater level measurements at the Site indicate that the localized overburden groundwater flow at the Site diverges from this general flow pattern, likely because of the influence of the two 42-inch diameter storm sewers that bisect the Site and the drainage ditch along the Site’s west and south perimeter. In both the shallow and deep overburden, groundwater at the Site appears to flow toward the two 42-inch storm sewers and converge in the area west of Building 82, where there is a depression of the groundwater surface in both the shallow and deeper portions of the overburden. The depression in the groundwater surface appears to be influenced by leakage to the storm sewers and/or groundwater flow through the bedding surrounding the storm sewers. Groundwater contour maps for the shallow and deep overburden from the October 2006 (seasonally low water table conditions) and April 2007 (seasonally high water table conditions) groundwater elevation monitoring events were generated in the RI and are shown in Figures 1-9, 1-10, 1-11, and 1-12, respectively. Groundwater velocities calculated from the results of the October 2006 and April 2007 groundwater elevation monitoring events are provided below. This information is used within the FS for evaluation and preliminary design of remedial alternatives.

Seasonal low groundwater conditions (October 2006)

- Shallow overburden aquifer - 1.59 feet per day (ft/d)
- Deep overburden aquifer - 0.0211ft/d)

Seasonal high groundwater conditions (April 2007)

- Shallow overburden aquifer - 2.28 ft/d
- Deep overburden aquifer - 0.0373 ft/d

A comprehensive synoptic water level round was conducted on April 21, 2011 as part of the RI Addendum activities. The shallow groundwater contours show an overall trend of groundwater flow to the southwest with localized flow to the west-southwest at Building 81 (possibly because of recharge from the unpaved area to the northwest) and immediately west of Building 82 where flow may be influenced by the bedrock trough and storm drains. Deep overburden groundwater flow is similar to that of the shallow overburden, with an apparent trough in the vicinity of B81-MW-47I and an area of relatively flat groundwater south and southwest of Building 15. Shallow and deep overburden groundwater contour maps are shown in Figures 1-13 and 1-14, respectively. The contour maps indicate groundwater flow generally to the southwest, with an essentially flat water table south of Building 15.

1.2.7 Nature and Extent of Contamination

This Section summarizes the nature and extent of chemicals detected at the Site as reported in the RI Report (TtNUS, 2010) and RI Addendum (TtNUS, 2011). Full details of the specific sampling locations/depths and the sample results compiled from the RI programs are available for review in Section 4 of the RI and the RI Addendum. The Navy's investigations at the site included sampling soil, groundwater, surface water, and sediment. The five soil sub-groups evaluated are: (1) exposed surface soil (to depths up to 2 feet bgs), (2) unexposed surface soil; (3) soil from 2 to 8 feet bgs; (4) subsurface soil from 8 to 20 feet bgs; and (5) subsurface soil deeper than 20 feet bgs. Because of shallow bedrock in the eastern portion of the TCE plume, the definitions of shallow and deep overburden aquifers were revised in the RI Addendum and are carried forward into this FS. Shallow overburden groundwater is considered to be from wells crossing the water table or from groundwater profiling samples collected immediately at or below the water table (e.g., the shallowest sample). All other groundwater samples are considered to be from the deep overburden.

Surface water results are divided into two sub-groups: samples collected from the storm sewer and those collected from the drainage ditch. Sediment results are presented in one group (all sediment samples were collected from the drainage ditch). Chemical parameters analyzed included Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), volatile petroleum hydrocarbons/extractable petroleum hydrocarbons (VPH/EPH), TCL pesticides, polychlorinated bi-phenyls (PCBs), and Target Analyte List (TAL) inorganics. The detections were compared to regulatory and risk-based screening criteria identified in the RI Work Plan (TtNUS, 2006), and background concentrations. USEPA Region 9 Preliminary Remediation Goals (PRGs), Massachusetts Maximum Contaminant Levels (MCLs), and non-zero Federal Maximum Contaminant Level Goals (MCLGs) were used as regulatory screening criteria. Risk-based screening criteria were compared to evaluate risks to human health and the environment.

Numerous VOCs were detected in Site soil, groundwater; and to a lesser extent surface water. The individual VOCs were generally detected at a low frequency and at relatively low concentrations. Only groundwater has VOC concentrations exceeding risk based criteria (Region 9 PRGs) in more than one sample. TCE exceeded its PRG in 14 of 135 samples.

Numerous SVOCs, mainly polycyclic aromatic hydrocarbons (PAHs), were detected in Site soil and sediment. Fewer SVOCs were detected in groundwater and surface water. The predominant PAHs detected in soil and sediment are benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. These compounds were most widely detected and present at the highest concentrations in exposed surface soil and sediment. Naphthalene is the most frequently detected PAH in groundwater (occurring in 10 of 84 samples) and is present at concentrations exceeding Region 9 PRGs in 7 of the 10 samples. Naphthalene was present in groundwater mainly in two areas, downgradient from GTM-2 and drain D5.

Pesticides were detected in all media sampled at the Site. However, the pesticides were generally detected infrequently and at low concentrations.

PCBs were detected in all media sampled at the Site. Aroclor-1260 is the only PCB detected in all media except deep groundwater. Aroclor-1260 was generally detected at low concentrations (not exceeding the Region 9 PRGs). A different PCB, Aroclor-1248, was detected in deep groundwater samples. Aroclor-1248 was detected and exceeded the Region 9 PRG in 4 of 12 deep groundwater samples analyzed as part of the 2006 RI investigations, including upgradient sample GW-MW07D-1006. The wells with PCB detections in 2006 were resampled in 2009; there were no PCBs detected in either the filtered or unfiltered samples. Additional monitoring for PCBs is discussed in subsequent sections in order to confirm that PCBs remain below Region 9 PRGs and if additional actions are warranted.

Numerous metals were detected in all media sampled at the Site. Four metals (arsenic, manganese, vanadium, and iron) are present in all media at concentrations exceeding Region 9 PRGs. However, concentrations of these metals in most samples are below Base background concentrations (where background values are available) and there is no apparent pattern of distribution of the elevated metals concentrations that would indicate a source of these metals. Reducing conditions in the aquifer can mobilize metals and thus contribute to the elevated metals concentrations in site groundwater.

1.3 CONTAMINANT FATE AND TRANSPORT

Generally, low concentrations of VOCs, SVOCs, pesticides, PCBs, and metals are present in Site soil, groundwater, surface water, and sediment. A limited number of chemicals in each of these contaminant classes were detected in some Site samples from each media at concentrations exceeding risk-based screening levels and Base background concentrations. The presence of these substances at the Site appears to be a result of: past activities at the Site relating to its former use as an airplane hangar; the onsite migration of contaminants from off-site sources; and anthropogenic and natural background conditions.

Contaminants that appear to be present as a result of past Site activities include: 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), TCE, benzene, 1,2,4-trimethylbenzene; benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and naphthalene; Aroclor-1260; and possibly Aroclor-1248 detected in groundwater in the western portion of the Site. Other VOCs [including methyl tert-butyl ether (MTBE)] and Aroclor-1248 that were detected in groundwater in the eastern portion of the Site appear to have migrated there from off-site sources. Low levels of pesticides and metals were also detected in Site media. However, pesticide presence appears to be related to general use of pesticides on the Base and metals presence is likely a natural background condition. A summary of the likely sources, transport pathways, and environmental fate of the contaminants detected at the Site during the RI and supplemental RI investigations is presented below. Sampling results from RI activities are included in Appendix A.

1.3.1 On-Site Sources

TCE Plume

As previously mentioned, the RI Addendum was completed to supplement the RI and further delineate the extent of contamination of the shallow and deep TCE plumes. The RI Addendum identified additional sources of groundwater contamination, including the storm sewer system southeast of Building 82. Since the TCE plumes delineated in the RI Addendum showed the TCE origin to be outside the original site boundaries, the Site was expanded to include the full TCE plume and Building 15.

TCE was detected in shallow and deep groundwater at relatively low concentrations (maximum 25 µg/L), with 14 detections above the MCL. One MCL exceedence was detected in shallow groundwater and 13 MCL exceedences were detected in deep groundwater.

Figure 1-15, from the RI Addendum, shows that the shallow overburden TCE plume is elongated from northeast to southwest. The southwest end of the plume terminates at MW-202S, by the storm sewer outfall.

The deep overburden groundwater results are shown in Figure 1-16, from the RI Addendum, which depicts an elongated plume extending from the southwest corner of Building 15. None of the concentrations in the vicinity of Building 41 or within the Building 15 footprint were above 5 µg/L. Concentrations ranged up to a maximum concentration of 25 µg/L east of MW-10D. However, this maximum concentration represented a depth of 16 to 20 feet bgs. This location is between well MW-10D (screened at 32 to 42 feet bgs) and profiling location H-04 (maximum depth of 30 feet bgs), so the concentration detected appears to be at least 10 feet above the top of bedrock.

The eastern side of the 10 µg/L contour coincides with catch basin C612, suggesting that the catch basin near the west side of Building 15 could be the source. Figure 1-17 shows the 1 µg/L and 5 µg/L contours for the deep plume and the 1 µg/L contour for the shallow plume superimposed over the storm drain system. The 1 µg/L deep groundwater contour encompasses the entire local storm drain system, moving from C612 southeast to C613, then north to M137/C609, west to M138, and then out to the outfall.

As mentioned above, the closest catch basins to the apparent source of the plume are C612 and C613, which are 3.31 and 4.95 feet bgs. The elevation of the C612 rim was 153.26 feet (NAVD 88). The closest groundwater profiling location is B82-J-05. The shallow sample at this location was collected from 6-10 feet bgs (TCE not detected) and the deep sample was collected from 2-0-22 feet bgs (14 µg/L TCE). There are two likely explanations for the lack of residual TCE in the nearby B82-J-05 sample: 1) during the field effort, the DPT samples were not put immediately adjacent to the catch basins in order to avoid potential damage to utilities; and 2) TCE in the shallow overburden groundwater may have entered through leaks into the catch basin and pipe material and thus migrated through the storm sewer system.

The pattern of contamination within the shallow overburden follows the path of the storm sewer, and the maximum concentrations within the deep overburden appear to follow a path from the southwest corner of Building 15 in the vicinity of the catch basins (which connect to the same storm sewer in the vicinity of the shallow groundwater concentrations). Given that the pattern of TCE contamination is bounded by non-detect concentrations (including non-detect groundwater profiling concentrations along the west side of Shea Memorial Drive as part of the Building 81 RI), the entire area is paved and has few other entry routes to groundwater, and Building 15 was a vehicle maintenance facility, Navy considers the catch basins to be most likely route of contamination.

Analysis of natural attenuation parameters (ORP and DO) suggest that TCE may be anaerobically biodegraded in the deep overburden groundwater. No daughter products of TCE were detected in any of the samples; therefore, biodegradation appears to be minimal.

Other On-Site Sources

Five primary on-site sources of contaminants detected in Site soil, groundwater, surface water, and sediment were identified in the RI based on evaluation of the concentrations and distribution of contaminants, contaminant properties, and the physical characteristics of the Site. Two of these locations were addressed as separate maintenance actions; see the Final Maintenance Activities Completion Report, TtEC, 2011, for details. These five sources are identified below and discussed in the following paragraphs in relation to the contaminants detected in Site media.

- Releases of liquid waste (fuels and solvents) from GTM-2, located immediately west of Building 82 at the terminus of FDS- 2.

- Releases of liquid waste (fuels and solvents) from a section of floor drain D5 between FDS-2 and FDS-3 in the shop area of Building 82.

- Exhaust from aircraft operating at and near the Site.
- Historical leaching of contaminants (PCBs) from the drainage ditch along the western perimeter of the Site.
- Subsurface site features (former roadway and drainage ditches) abandoned prior to construction of Building 82.

GTM-2 Release Area

Most of the maximum concentrations of VOCs and SVOCs detected in Site groundwater and VOCs detected in soils were found in samples collected in the area around and downgradient from GTM-2 at the approximate depth of the base of the manhole (11 to 13 feet). Elevated concentrations of some of these contaminants were also detected in deeper samples in the area, but the concentrations generally decreased with depth below 13 feet bgs.

Contaminants were likely released into the soil and groundwater surrounding GTM-2 until Base operations ceased in 1996 (and discharge of liquids into the floor drain system ceased). Minor releases may have continued until the source material was removed from the manhole during drain system cleaning in 1998. Since completion of the GTM cleaning, contaminants sorbed to soil in the vicinity of GTM-2 may have remained as a continuing source of dissolved contaminants to groundwater. Based on groundwater flow directions described in Section 3.3.2 of the RI, dissolved contaminants from this area may migrate in groundwater by advection toward and into the eastern storm sewer, where preferential flow in the sewer and bedding materials transport them south-southeastward. Contaminants in surface water within the storm sewer may discharge to the drainage ditch at the south of the Site. Contaminants migrating within the bedding materials may discharge into the drainage ditch or continue migrating farther south.

GTM-2, along with the other three GTMs, was removed in 2010 as part of a maintenance action (TtEC, 2011). Piping associated with each GTM was removed as was impacted soil in each of the four excavations. None of the confirmatory samples collected from the sidewalls and floor of the excavations exceeded the cleanup criteria.

Floor Drain D5 Release Area

Several VOCs, including benzene, 1,2,4-trimethylbenzene, and naphthalene were detected at concentrations exceeding Region 9 PRGs in groundwater samples from profiling location GP-D02, near the north end of Drain D5. Low concentrations of 1,2,4-trimethylbenzene and naphthalene, as well as several other PAHs, were detected in soils in the adjacent direct push technology (DPT) boring location.

The concentrations of contaminants in the soils and groundwater in this area were low relative to those detected near GTM-2. Based on these data, small releases of liquid waste (primarily fuels) may have occurred from drain D5 in the shop area of Building 82.

Soil samples were collected from borings completed at floor drain D5, and also D4 and D6, as part of the 2010 maintenance action (TtEC, 2011). The analytical results were screened against the cleanup criteria established in the work plan; there were no exceedances.

Exhaust from Aircraft Operating at and Near the Site

The likely sources of most of the PAH contaminants detected in Site soil and sediment are residuals from fuel spills on the apron areas and/or deposition of airborne products of incomplete combustion from the exhaust of aircraft operating at and near the Site. The basis for this conclusion is that the predominant PAHs detected on the Site (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene), and naphthalene are ubiquitous products of incomplete combustion of organic matter such as fuels, and that these compounds were most widely detected and present at the highest concentrations in exposed surface soil and sediment. These compounds were detected less frequently and at lower concentrations in unexposed surface soils and subsurface soils, and both their concentrations and frequency of detection generally decreased with depth.

The presence of these PAHs in covered and subsurface soils may be explained by the fact that much of the area was filled during Base construction and existing soils were further disturbed and reworked during construction of Building 82. Consequently, PAHs that were deposited on surface soils in the past, both on the Site and in areas that were sources of the fill materials now present on the Site, may have been moved into the subsurface, adsorbed to the fill materials and reworked surface soil. The absence of these PAHs in groundwater and drainage ditch surface water is attributable to the relative insolubility of these compounds and their strong sorption potential.

Past Leaching of PCBs from the Western Site Drainage Ditch

The drainage ditch located along the western Site perimeter may be a source of Aroclor-1248 detected in groundwater in 2006 at wells MW-11D and MW08-016D in the western portion of the Site. The ditch west and southwest of the Site was the subject of a removal action conducted in 2002 to address sediments containing PCBs, SVOCs, and metals at concentrations above risk-based criteria. Prior to the removal action, PCBs present in surface water in the ditch may have migrated to groundwater during periods of surface water discharge into groundwater. However, the absence of PCBs in the groundwater samples collected in 2009 suggests that the PCBs previously detected were either intermittent, sorbed onto soil particles in the groundwater (this appears unlikely, as no correlation was found with sample turbidity), or a result of cross-contamination (also unlikely, as two different Aroclors were found in different wells, and the samples with PCBs were collected over a period of at least 2 weeks).

Former Roadway and Drainage Ditches

Portions of the site had been backfilled and re-graded prior to construction of Hangar 2. A roadway and pipelines originally ran north-northwest to south-southeast across the center of the site, and two drainage ditches connected just south of the current facility. During test pit excavation, remnants of what appeared to be the original roadway (a bituminous material) and pipelines were encountered. One test pit targeted the former ditch, which may have been a preferential pathway for subsurface contamination or contaminated directly while in use.

The test pit did not reveal significant differences between apparent ditch material and the surrounding fill, so the ditches do not appear to be likely conduits for groundwater contamination. Soil samples that were collected beneath former site features had elevated metals and SVOC concentrations, and the sample collected directly beneath the bituminous material had elevated pesticide and PCB concentrations. However, downgradient wells did not have elevated concentrations of these relatively insoluble compounds.

1.3.2 Potential Off-Site Sources

The evaluation of Site data indicates that some of the contaminants detected in Site groundwater may be migrating onto the Site from sources located northeast and east of the Site. These potential off-site contaminant sources are discussed below.

Potential Source of TCE East-Southeast of the Site

The position of the two plumes strongly suggests that some amount of TCE was released or otherwise transported into the catch basin (C612) closest to the south side of Building 15. A portion of it may have penetrated through the brick walls or floor of the catch basin and moved with the flow of groundwater toward the west. Another portion appears to have travelled within the storm sewer north and then west, causing a larger plume with concentrations less than 1 µg/L. Shallow groundwater concentrations may have been greatly reduced over time by either preferential groundwater flow (either natural or via backfill, such as would be expected in the former UST No. 12 tank grave) or by dilution from a leaking sewer pipe.

Alternately, TCE in the shallow groundwater may have been degraded preferentially because of favorable conditions.

Pipe, manhole, and catch basin inspections were performed as part of the TACAN Outfall closeout report (TtEC, 2008). The locations in question (manholes 137 through 139 and catch basins 608 through 613) were examined during inspections 4 through 10 on October 31 and November 4, 2002. All sections were found to be in fair condition, except for the connections between (1) manhole 137 and catch basin 609 and (2) catch basin 609 and catch basin 608, which were in excellent condition.

TCE was not detected on the west side of the north-south storm sewers in either the deep or shallow groundwater, so the TCE may have either been degraded (although no daughter products have been detected) or moved vertically either into the bedrock or up into the shallow zone before exiting through the outfall.

The storm sewer system implicated does not intersect with any storm sewers in the vicinity of the Building 81 site or any of its associated plumes. In addition, of the 72 samples collected for the supplemental groundwater profiling investigations, no other chlorinated solvents have been detected. Two shallow groundwater samples in the area contained low concentrations of tetrachloroethene (PCE) (less than the MCL); however, these samples were from B82-MW-03 and B82-MW-203S, more than 100 feet from the existing shallow TCE plume.

The absence of PCE, the TCE concentrations less than 0.5 µg/L for wells B81-MW-48I and B81-MW-49I upgradient of the plume, and the absence of connecting preferential pathways between the two sites indicate that the TCE concentrations are not associated with contamination from Building 81.

Potential Source(s) of MTBE Northeast of the Site

MTBE is the most widely distributed VOC in Site groundwater, but it was not detected in Site soil or sediment. MTBE is widely distributed in deep groundwater extending from upgradient locations MW-07D and MW-201D north and northeast of Building 82, south to the building's southern edge, and west to areas immediately west of the storm sewer lines, where there is generally an upward vertical gradient from the deep to shallow overburden. However, in wells located farther west (MW-11D and MW08-016D), where the groundwater flow direction is generally from west to east, MTBE is not detected.

The pattern of MTBE distribution in deep groundwater wells, in combination with general groundwater flow directions at the Site and the absence of MTBE in Site soil, indicate that the MTBE detected in Site groundwater is from an off-site source to the northeast of the Site. It is likely that the limited presence of

MTBE in shallow groundwater is a result of the more extensive deep groundwater contamination discharging upward to shallow overburden.

1.3.3 Background Conditions

Gamma chlordane and heptachlor epoxide are manufactured chemicals that were historically used as pesticides in the United States. These and many other pesticides are very persistent in the environment. Based on these factors, the low frequency of detection and generally low concentrations of pesticides in all media, the absence of a significant presence of pesticides in Site soil and sediment, and the presence of pesticides in upgradient groundwater samples, it appears that pesticide presence in Site media is not related to Site operations or activities. Pesticide presence is likely a background condition related to general pesticide use on the Base.

Four metals (arsenic, manganese, vanadium, and iron) are present in Site samples from all media, often at concentrations exceeding Region 9 PRGs. However, concentrations of these metals in most samples are below Base background concentrations (where background values are available) and there is no apparent pattern of distribution of the elevated metals concentrations that would indicate a source of these metals. Arsenic, manganese, vanadium, iron, and many other metals are naturally occurring elements present in bedrock. Soils are generally derived from bedrock and are comprised of metals occurring naturally in the rock; therefore, many metals are ubiquitous in soils and other media, at varying concentrations.

Based on the natural presence of arsenic, manganese, vanadium, and iron in the earth's crust; the presence of these metals in all media, predominantly at concentrations below Base background levels; and the absence of a defined distribution pattern of elevated metals concentrations at the Site, it appears that presence of these metals in Site media is not related to Site operations or activities. The ubiquitous presence of these metals in Site media is likely a natural background condition.

1.4 RISK ASSESSMENT

The following sections summarize the RI human health and ecological risk assessments for the Site.

1.4.1 Human Health Risk

A baseline human health risk assessment (HHRA) was conducted to identify potential risks from contaminants in soil, groundwater, and drainage ditch sediment and surface water at the Building 82 Site. The data used in the risk assessment represent site conditions after completion of the drain removal actions mentioned in Section 1.2.2.

Potential unacceptable risks were identified in the HHRA for future residents primarily from use of groundwater as drinking water, and for future construction workers from inhalation of dust and inhalation of volatile contaminants in trench air.

For future residents, under the reasonable maximum exposure (RME) conditions evaluated, groundwater used as drinking water is the only pathway with single medium and organ-specific hazard indices (HIs) for non-carcinogenic effects exceeding 1 and the only medium with cancer risks exceeding the USEPA cancer risk range (10^{-4} to 10^{-6}). The calculated RME non-carcinogenic HIs and cancer risks for future adult and child residents use of groundwater as drinking water are: HI = 9 and cancer risk = 1×10^{-4} (adult) and HI = 31 and cancer risk = 2×10^{-4} (child). Note that the adult resident cancer risk is equal to but does not exceed the upper limit of the USEPA cancer risk range. The calculated RME lifetime cancer risk (including exposure to all media) for future residents is 4×10^{-4}. The major contributors to the RME HIs greater than 1.0 in groundwater are: manganese and arsenic. The major contributors to cancer risk greater than 1×10^{-4} in groundwater are arsenic, TCE, n-nitroso-di-n-propylamine (NNPA), Aroclor-1248, heptachlor epoxide, benzene, 1,1-DCA, PCE, and chloroform, which have been retained as Contaminants of Concern (COCs) for the Building 82 Site. The locations and comparative levels of TCE and manganese are depicted on Figures 1-15 through 1-19.

While the HHRA found that there was a potential risk for future construction workers from inhalation of dust and volatiles in trench air, additional risk analysis performed since the time of the HHRA has shown that no construction worker risk is present at the Building 82 Site. In addition, the 2010 maintenance action removed COCs in soils. The HHRA also concluded that no unacceptable risks to building occupants or residents exist from surface water, or from inhalation of volatile constituents in groundwater at the Building 82 Site. No unacceptable risks to human health were identified in soil or sediment.

Human health risk assessment calculations prepared for the FS are included in Appendix B.

1.4.2 <u>Ecological Risk</u>

An Ecological Risk Assessment (ERA) was conducted to evaluate the potential for adverse ecological impacts of site-related contamination in exposed surface soil and drainage ditch surface water and sediment, and to determine the need for further investigation and/or remedial action at the Site. Although several chemicals were initially selected as contaminants of potential concern for ecological receptors, it was determined that the risks to terrestrial plants and invertebrates, sediment invertebrates, aquatic organisms, and terrestrial receptors at the Site were not great enough for any chemicals to warrant further evaluation of ecological risk at this Site.

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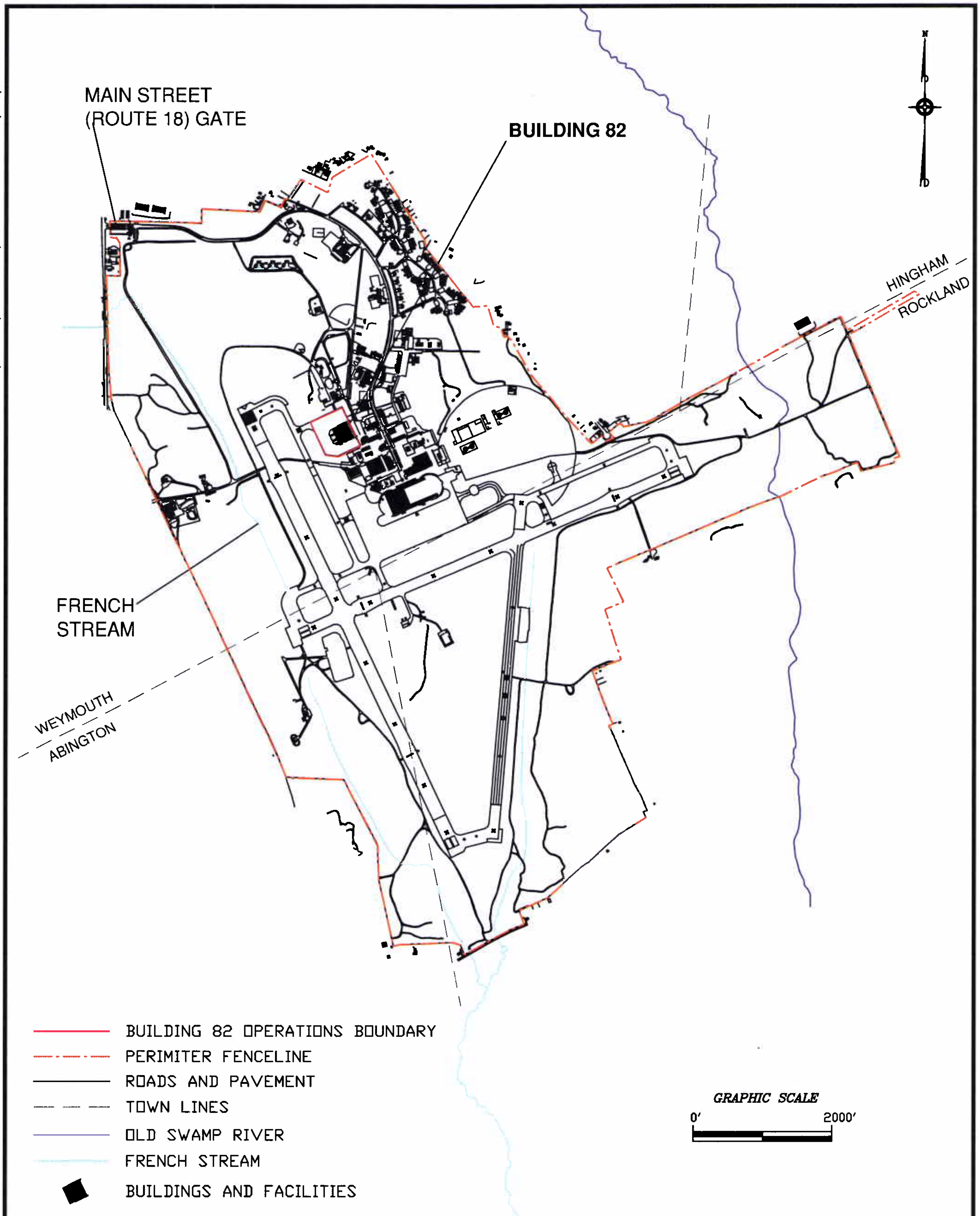

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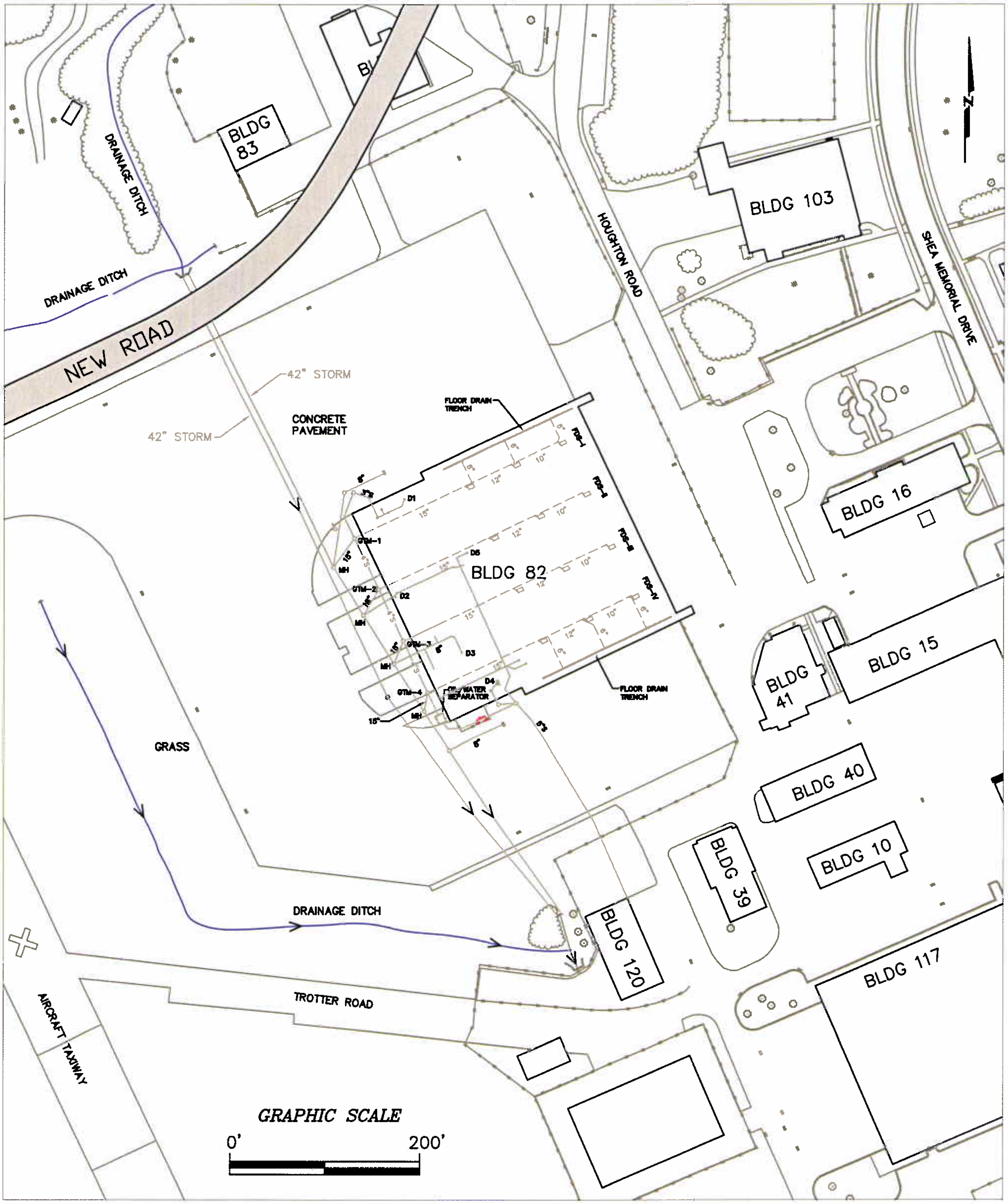

TETRA TECH NUS, INC.

BUILDING 82 SITE MAP
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WEYMOUTH, MASSACHUSETTS

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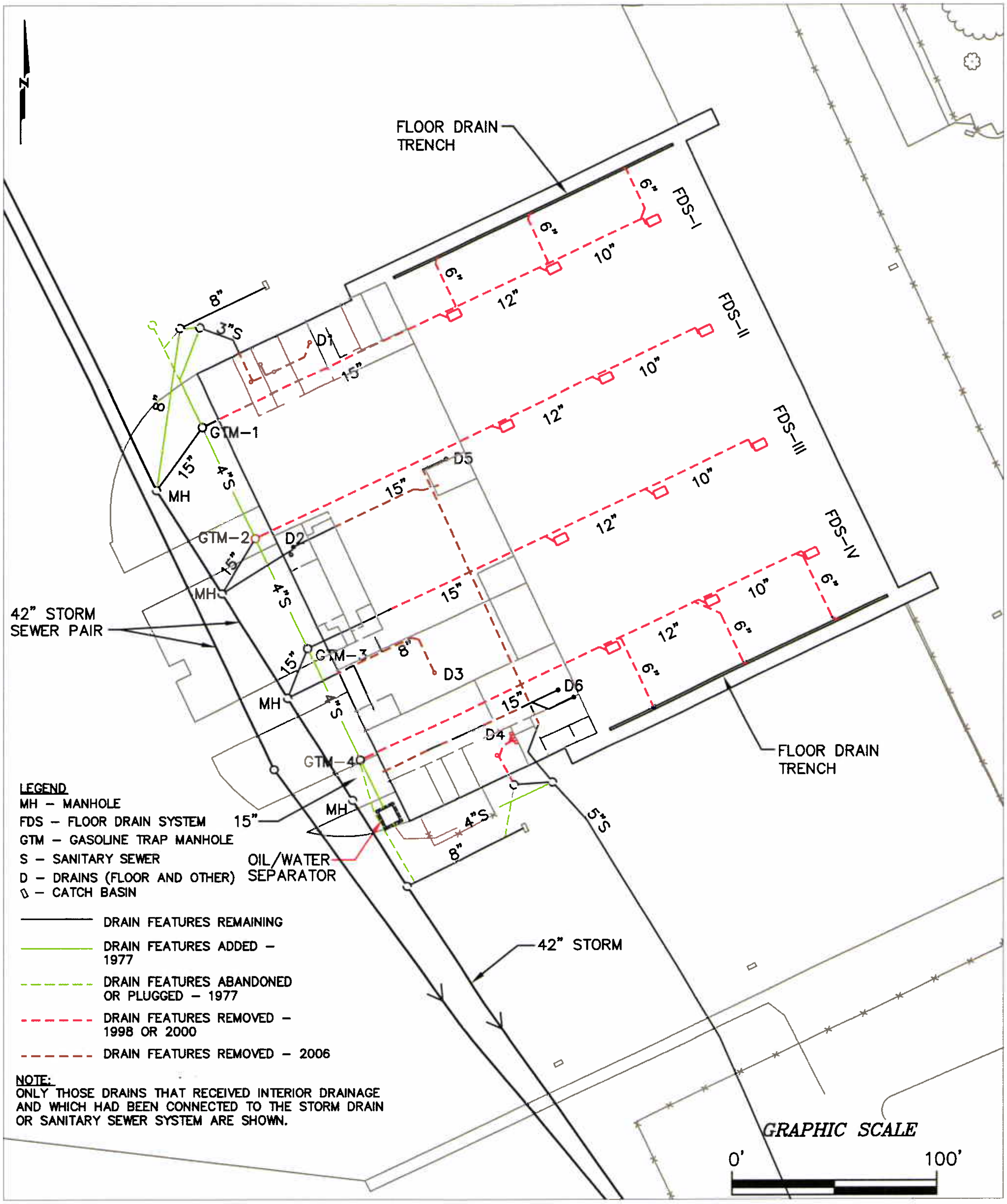
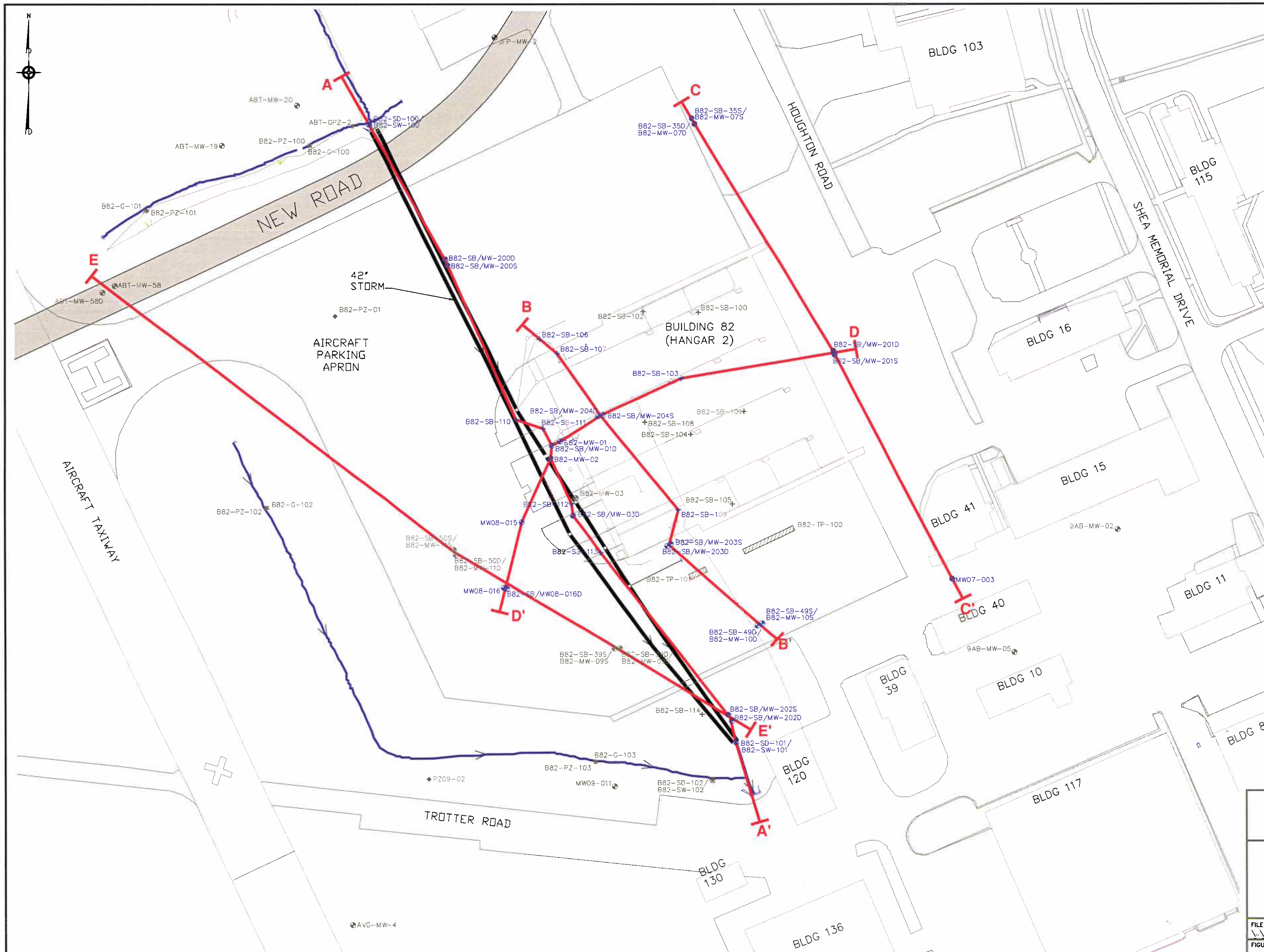


TETRA TECH NUS, INC.

DRAINAGE SYSTEM
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

SCALE	AS NOTED
FILE	\..\DRAIN.DWG
REV 0	DATE 09/03/10
FIGURE NUMBER	1-3



LEGEND

B82-SB/MW-204S	SOIL BORING/MONITORING WELL USED FOR GEOLOGIC CROSS-SECTIONS
B82-SB-109	SOIL BORING USED FOR GEOLOGIC CROSS-SECTIONS
B82-SD-101/ B82-SW-101	SURFACE WATER/ SEDIMENT SAMPLE LOCATION USED FOR GEOLOGIC CROSS-SECTIONS
9AB-MW-02	MONITORING WELL NOT USED FOR GEOLOGIC CROSS-SECTIONS
B82-SB-101	SOIL BORING NOT USED FOR GEOLOGIC CROSS-SECTIONS
ABT-GPZ-2	PIEZOMETER LOCATION
B82-SD-102/ B82-SW-102	SURFACE WATER/ SEDIMENT SAMPLE NOT USED FOR GEOLOGIC CROSS-SECTIONS
B82-G-101	STAFF GAUGE LOCATION
B82-TP-100	TEST PIT
A—A	CROSS-SECTION LINE

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.

GRAPHIC SCALE

50' 0' 50 100'

TETRA TECH NUS, INC.

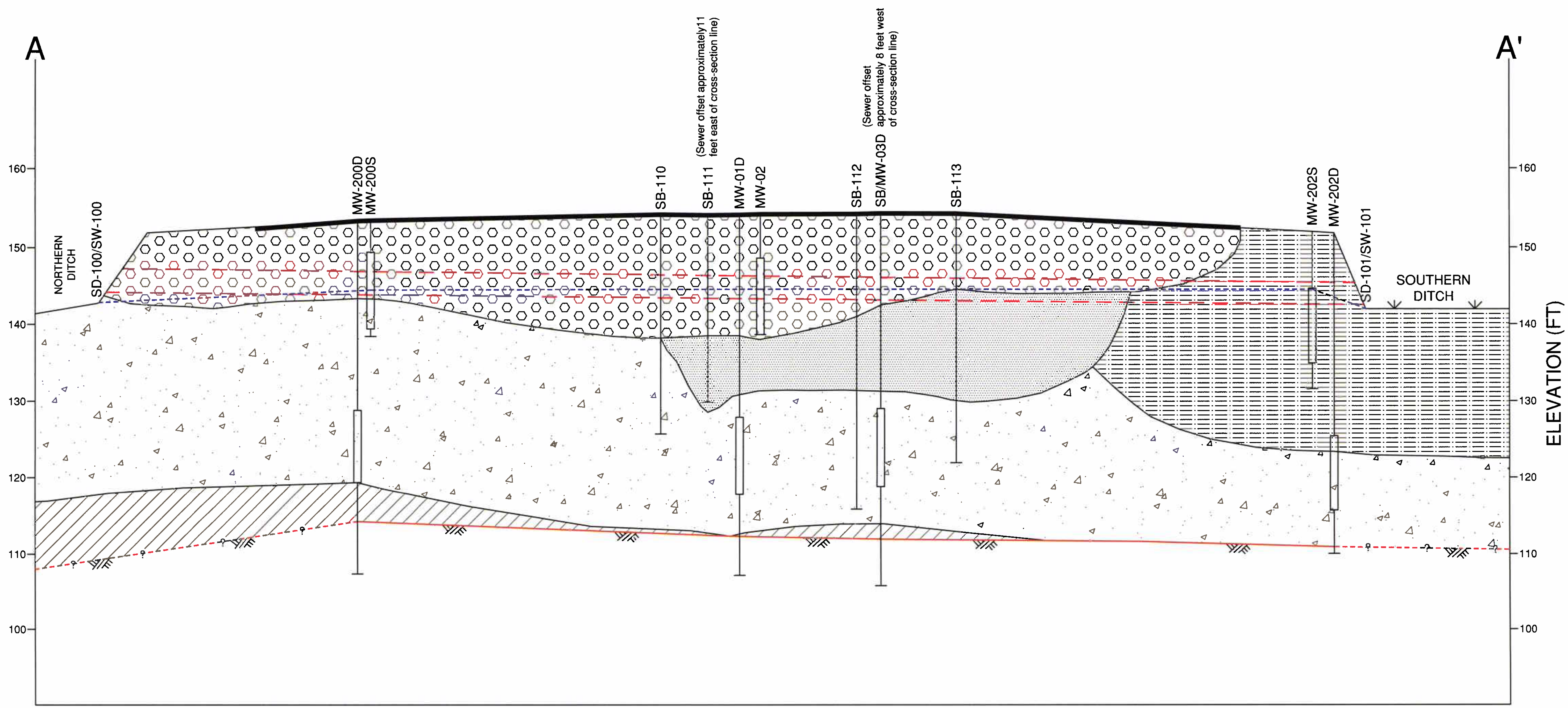
GEOLOGICAL CROSS-SECTION LOCATION MAP
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\X-SECTION_LINES.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-4	0	09/03/10

ACAD: \02073\FS.DF.B82\X-SECTION_LINES.DWG 09/03/10 DWW

ACAD: \02073\FS.DF.B82\X-SECTIONS.DWG 08/11/10 DWM



ASPHALT OR CONCRETE SURFACE

SANDY FILL (INTERPRETED)

SAND AND SILT

SAND

SAND, SILT, AND GRAVEL (POTENTIAL TILL)

SILT AND CLAY

SB/MW-03D — SOIL BORING / WELL LOCATION ID

GROUND SURFACE

TOP OF WELL SCREEN

BOTTOM OF WELL SCREEN

BOTTOM OF BORING

GRAPHIC SCALE 0' 50' 100'

SHALLOW GROUNDWATER ELEVATION (NOVEMBER 30, 2006)

ELEVATION OF BEDROCK (ESTIMATED BETWEEN BORINGS WHERE BEDROCK CONFIRMED)

APPROXIMATE LOCATION OF EAST 42 INCH DIAMETER STORM SEWER

ELEVATIONS IN NGVD 1929, FEET

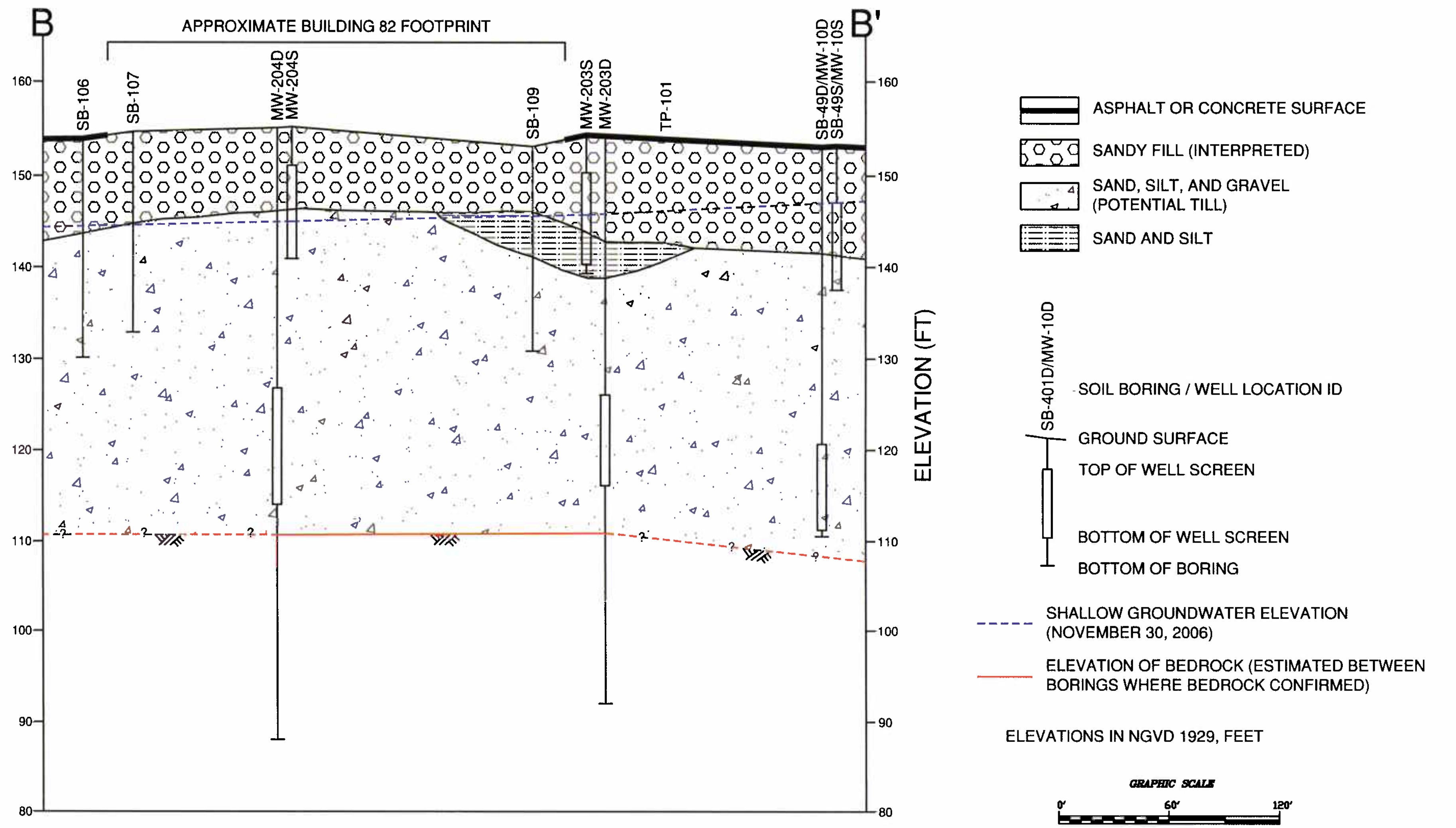
TETRA TECH NUS, INC.

GEOLOGICAL CROSS-SECTION A-A'
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\X-SECTIONS.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-5	0	08/11/10

ACAD: \02073\FS.DF.B82\X-SECTIONS.DWG 08/11/10 DWM

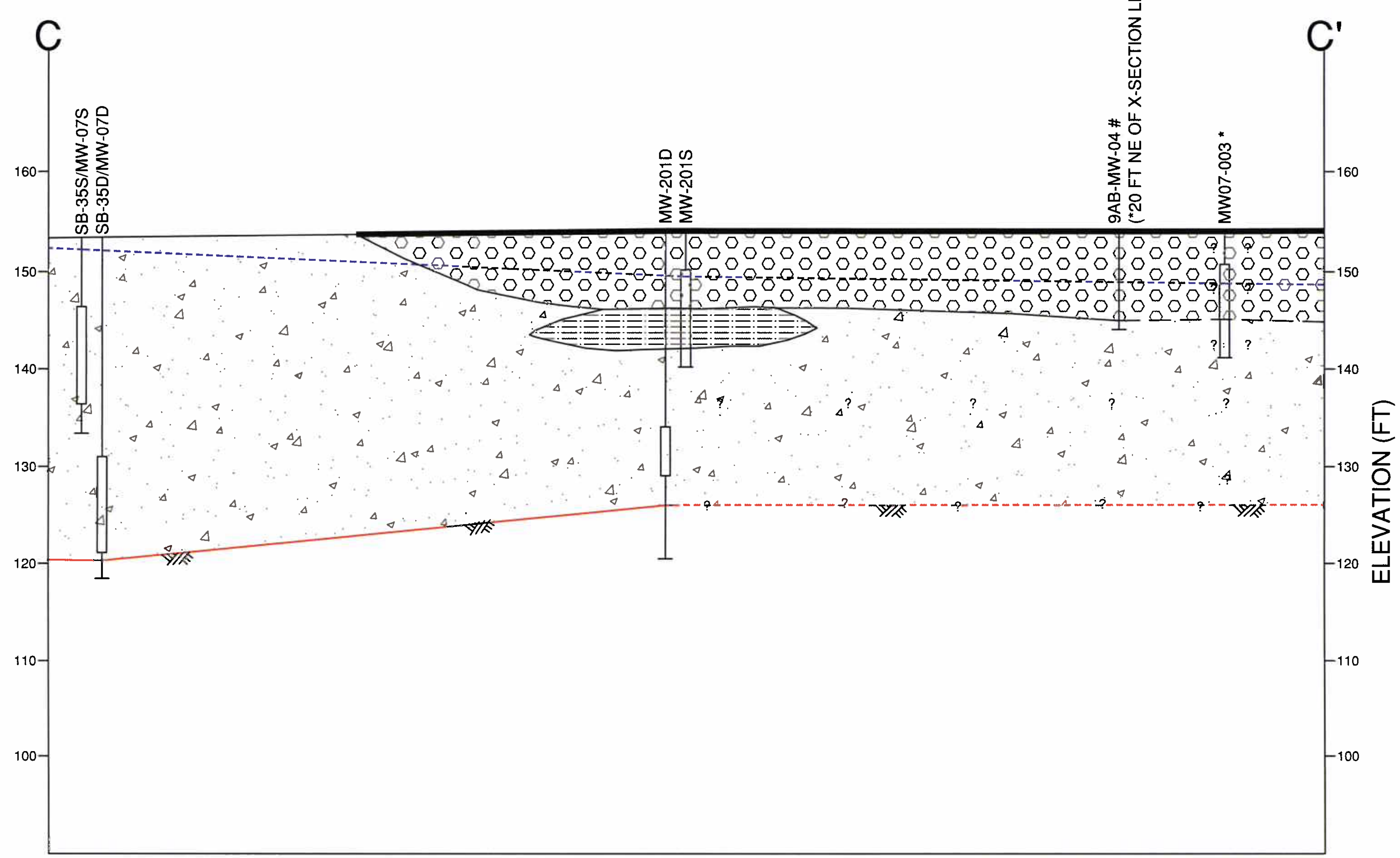


TETRA TECH NUS, INC.

GEOLOGICAL CROSS-SECTION B-B'
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

SCALE	AS NOTED
FILE	\..\X-SECTIONS.DWG
REV	0
DATE	08/11/10
FIGURE NUMBER	1-6

ACAD: \00028\0625\X-SECTIONS.DWG 08/30/10 DWM



ASPHALT OR CONCRETE SURFACE

SANDY FILL (INTERPRETED)

SAND AND SILT

SAND, SILT, AND GRAVEL (POTENTIAL TILL)

SB-35S/MW-07S — SOIL BORING / WELL LOCATION ID

GROUND SURFACE

TOP OF WELL SCREEN

BOTTOM OF WELL SCREEN

BOTTOM OF BORING

GRAPHIC SCALE 0' 50' 100'

SHALLOW GROUNDWATER ELEVATION (NOVEMBER 30, 2006)

ELEVATION OF BEDROCK (ESTIMATED BETWEEN BORINGS WHERE BEDROCK CONFIRMED)

- SHALLOW STRATIGRAPHY BASED ON DESCRIPTION IN ENSR 2000

* - NO SOIL DATA, WELL CONSTRUCTION AND WATER ELEVATION DATA ONLY

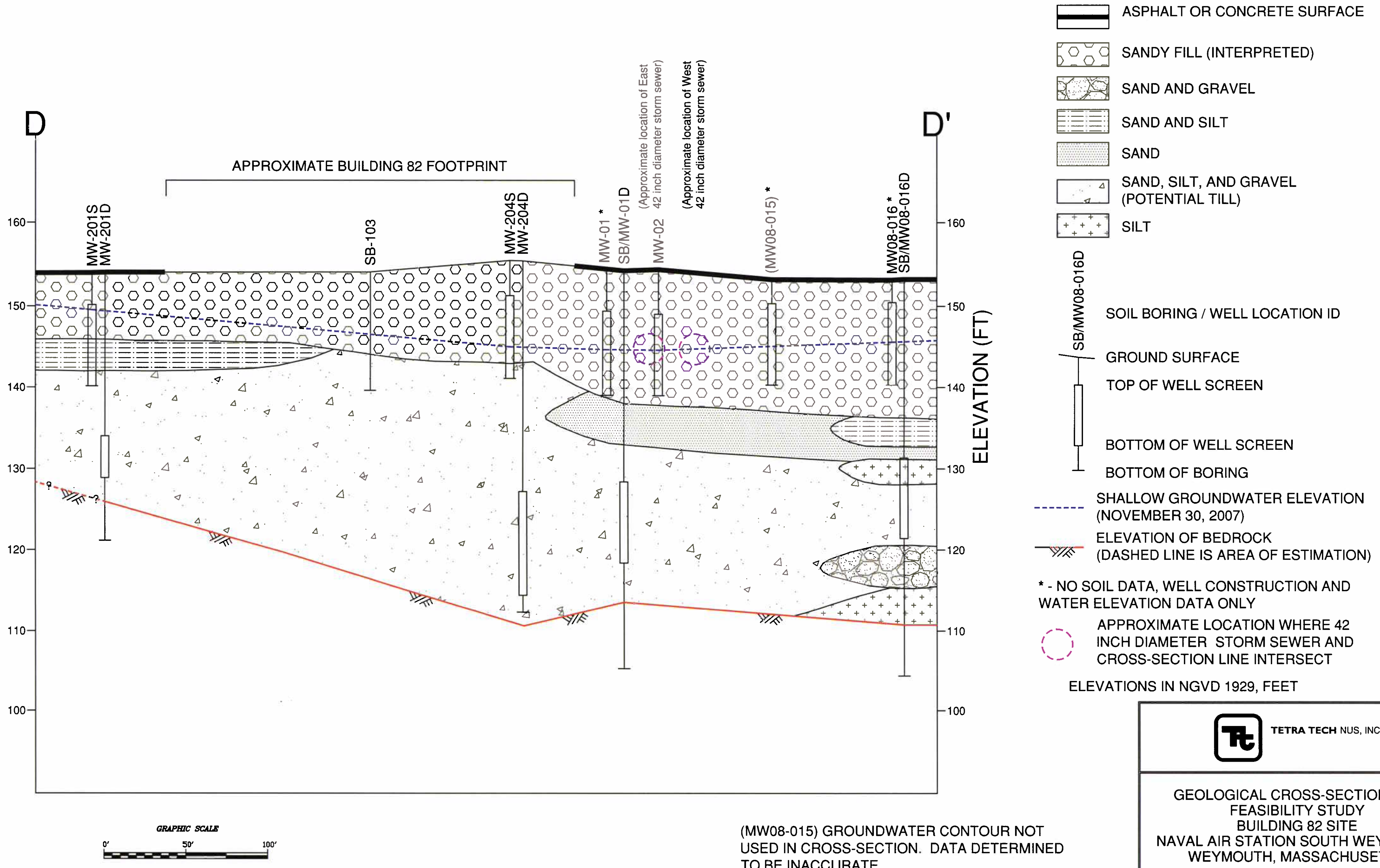
ELEVATIONS IN NGVD 1929, FEET

TETRA TECH NUS, INC.

GEOLOGICAL CROSS-SECTION C-C'
REMEDIAL INVESTIGATION REPORT
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\00028\0625\X-SECTIONS.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-7	0	08/30/10



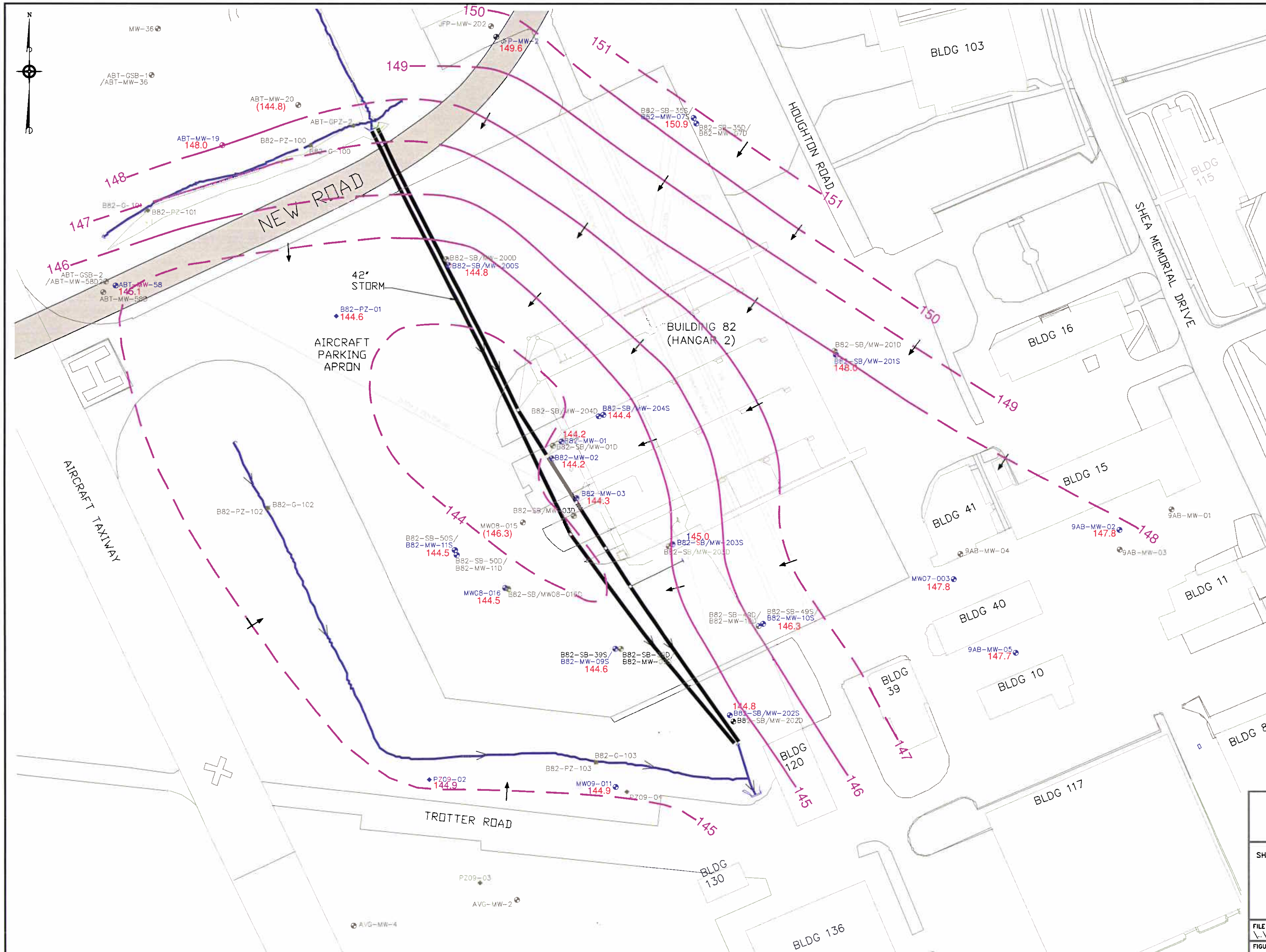
(MW08-015) GROUNDWATER CONTOUR NOT USED IN CROSS-SECTION. DATA DETERMINED TO BE INACCURATE.

TETRA TECH NUS, INC.

GEOLOGICAL CROSS-SECTION D-D'
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE \..\X-SECTIONS.DWG	SCALE AS NOTED	
FIGURE NUMBER 1-8	REV 0	DATE 08/30/10

ACAD: \02073\FS.DF.B82\X-SECTIONS.DWG 08/30/10 DWM



LEGEND

B82-SB/MW-204S	MONITORING WELL USED FOR CONTOURS ON THIS FIGURE
B82-PZ-01	STREAM PIEZOMETER USED FOR CONTOURS ON THIS FIGURE
B82-SB/MW-204D	MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE
B82-G-101	STAFF GAUGE LOCATION
ABT-GPZ-2	PIEZOMETER NOT USED FOR CONTOURS ON THIS FIGURE
150 — — —	GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)
150.9	MEASURED GROUNDWATER ELEVATION (FEET)
(146.3)	GROUNDWATER ELEVATION NOT CONTOURED. DATA DETERMINED TO BE INACCURATE.
←	GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. GROUNDWATER ELEVATIONS MEASURED OCTOBER 24, 2006 BY TtNUS.

GRAPHIC SCALE

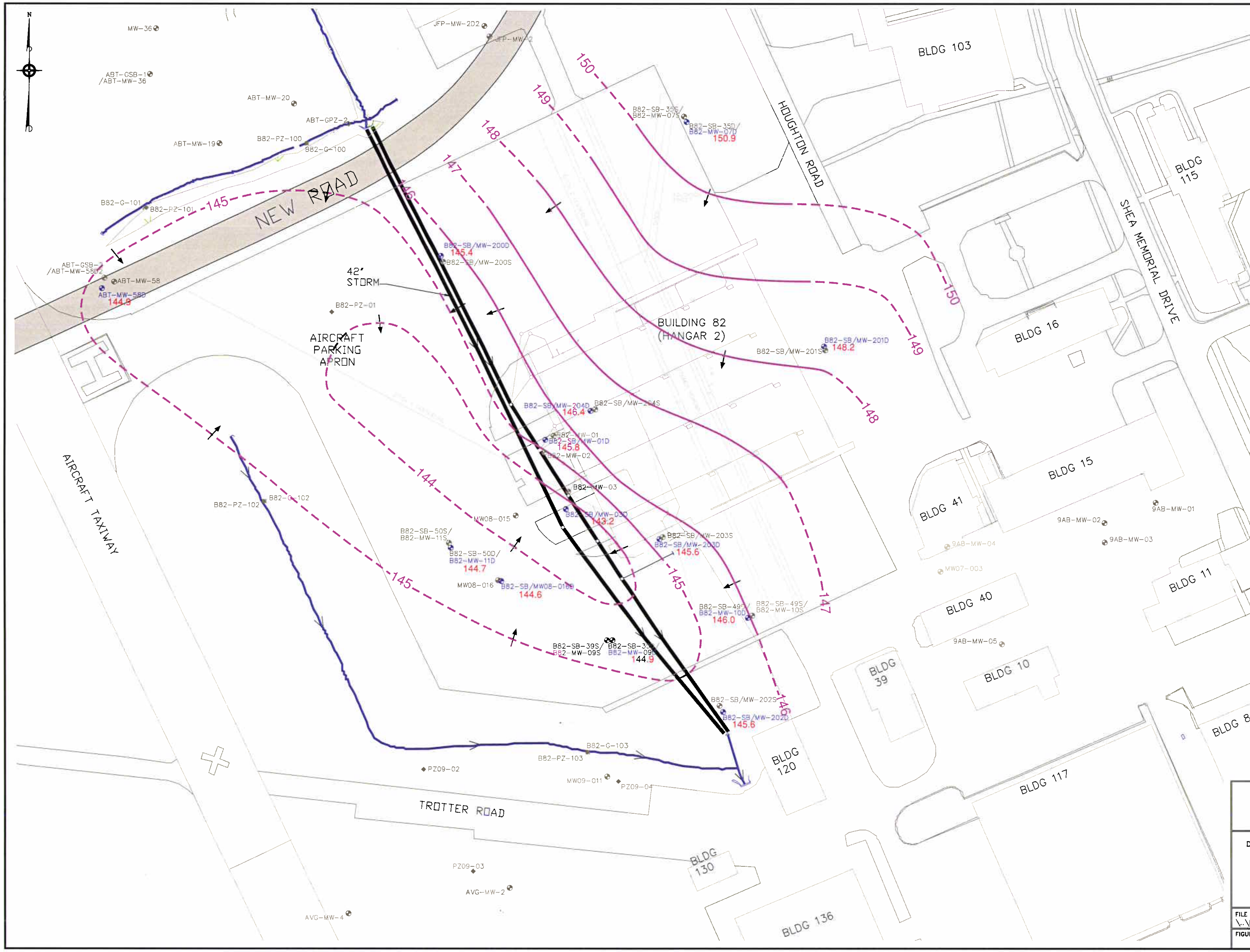
50' 0' 50 100'

TETRA TECH NUS, INC.

SHALLOW OVERBURDEN GROUNDWATER CONTOUR MAP
OCTOBER 24, 2006
REMEDIAL INVESTIGATION REPORT
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE	
\..\SHALL_OB_CONT_102406.DWG	AS NOTED	
FIGURE NUMBER	REV	DATE
1-9	0	09/03/10

ACAD- \02073\FS.DF.B82\SHALL_OB_CONT_102406.DWG 09/03/10 DWM



LEGEND

B82-SB/MW-204D — MONITORING WELL USED FOR CONTOURS ON THIS FIGURE

B82-SB/MW-204S — MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE

B82-G-101 — STAFF GAUGE LOCATION

ABT-GPZ-2 — PIEZOMETER

150 — GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)

150.9 — MEASURED GROUNDWATER ELEVATION (FEET)

← — GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. GROUNDWATER ELEVATIONS MEASURED OCTOBER 24, 2006 BY TtNUS.

GRAPHIC SCALE

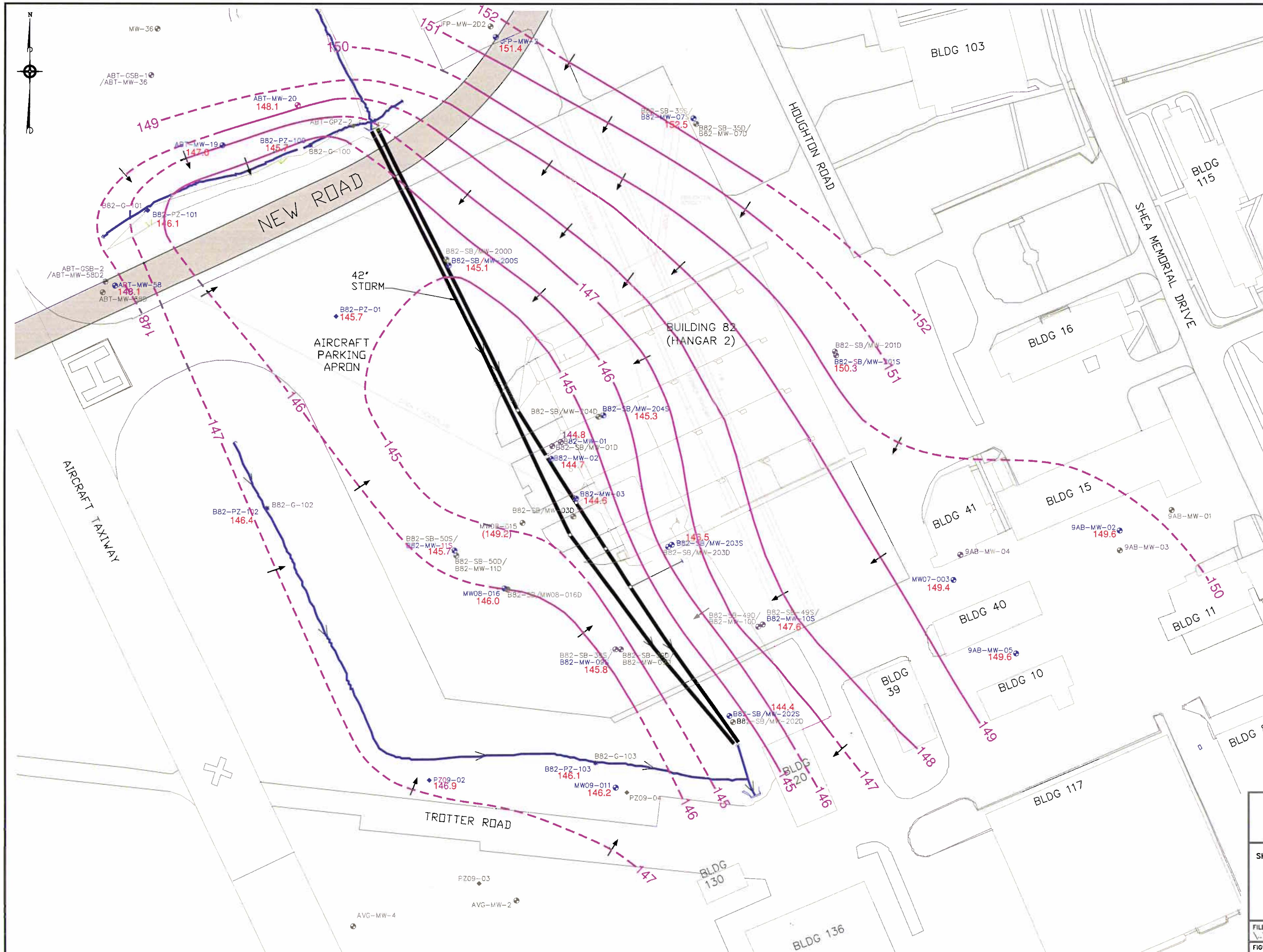
50' 0' 50 100'

TETRA TECH NUS, INC.

DEEP OVERBURDEN GROUNDWATER CONTOUR MAP
OCTOBER 24, 2006
REMEDIAL INVESTIGATION REPORT
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\DEEP_OB_CONT_102406.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-10	0	09/03/10



LEGEND

B82-SB/MW-204S	MONITORING WELL USED FOR CONTOURS ON THIS FIGURE
B82-PZ-01	STREAM PIEZOMETER USED FOR CONTOURS ON THIS FIGURE
B82-SB/MW-204D	MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE
B82-G-101	STAFF GAUGE LOCATION
PZ09-04	STREAM PIEZOMETER NOT USED FOR CONTOURS ON THIS FIGURE
150 — — —	GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)
149.6	MEASURED GROUNDWATER ELEVATION (FEET)
(149.2)	GROUNDWATER ELEVATION NOT CONTOURED. DATA DETERMINED TO BE INACCURATE.
←	GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
5. GROUNDWATER ELEVATIONS MEASURED APRIL 26, 2007 BY TtNUS.

GRAPHIC SCALE

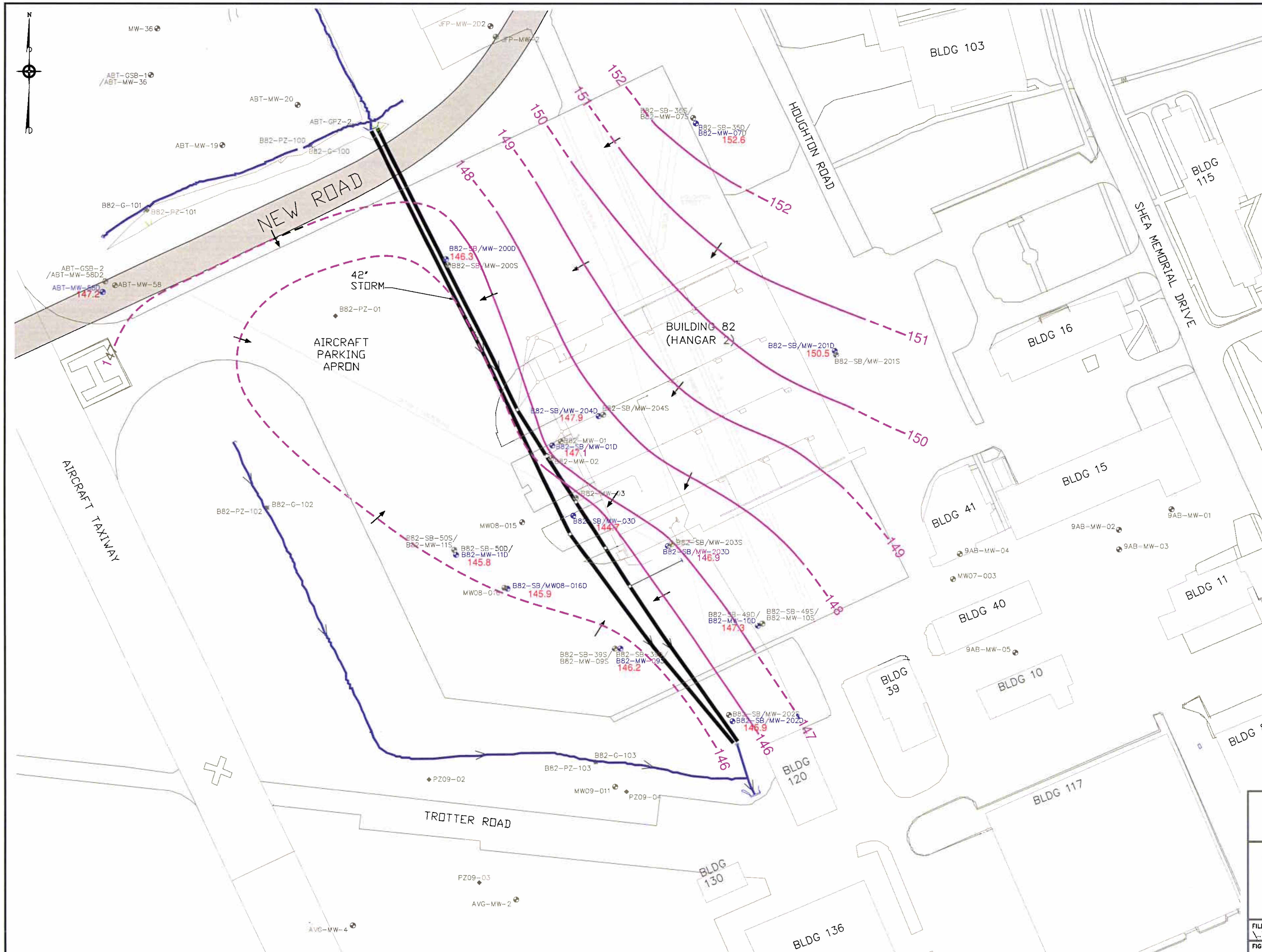
50' 0' 50 100'

TETRA TECH NUS, INC.

SHALLOW OVERBURDEN GROUNDWATER CONTOUR MAP
APRIL 26, 2007
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\SHALL_OB_CONT_042607.DWG	AS NOTED
FIGURE NUMBER 1-11	REV 0 DATE 09/03/10

ACAD: \02073\FS.OF.B82\SHALL_OB_CONT_042607.DWG 09/03/10 DWM



LEGEND

B82-SB/MW-204D	MONITORING WELL USED FOR CONTOURS ON THIS FIGURE
B82-SB/MW-204S	MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE
B82-G-101	STAFF GAUGE LOCATION
ABT-GPZ-2	STREAM PIEZOMETER
150 — — —	GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)
150.9	MEASURED GROUNDWATER ELEVATION (FEET)
←	GROUNDWATER FLOW DIRECTION

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. GROUNDWATER ELEVATIONS MEASURED APRIL 26, 2007 BY TtNUS.

GRAPHIC SCALE

50' 0' 50 100'

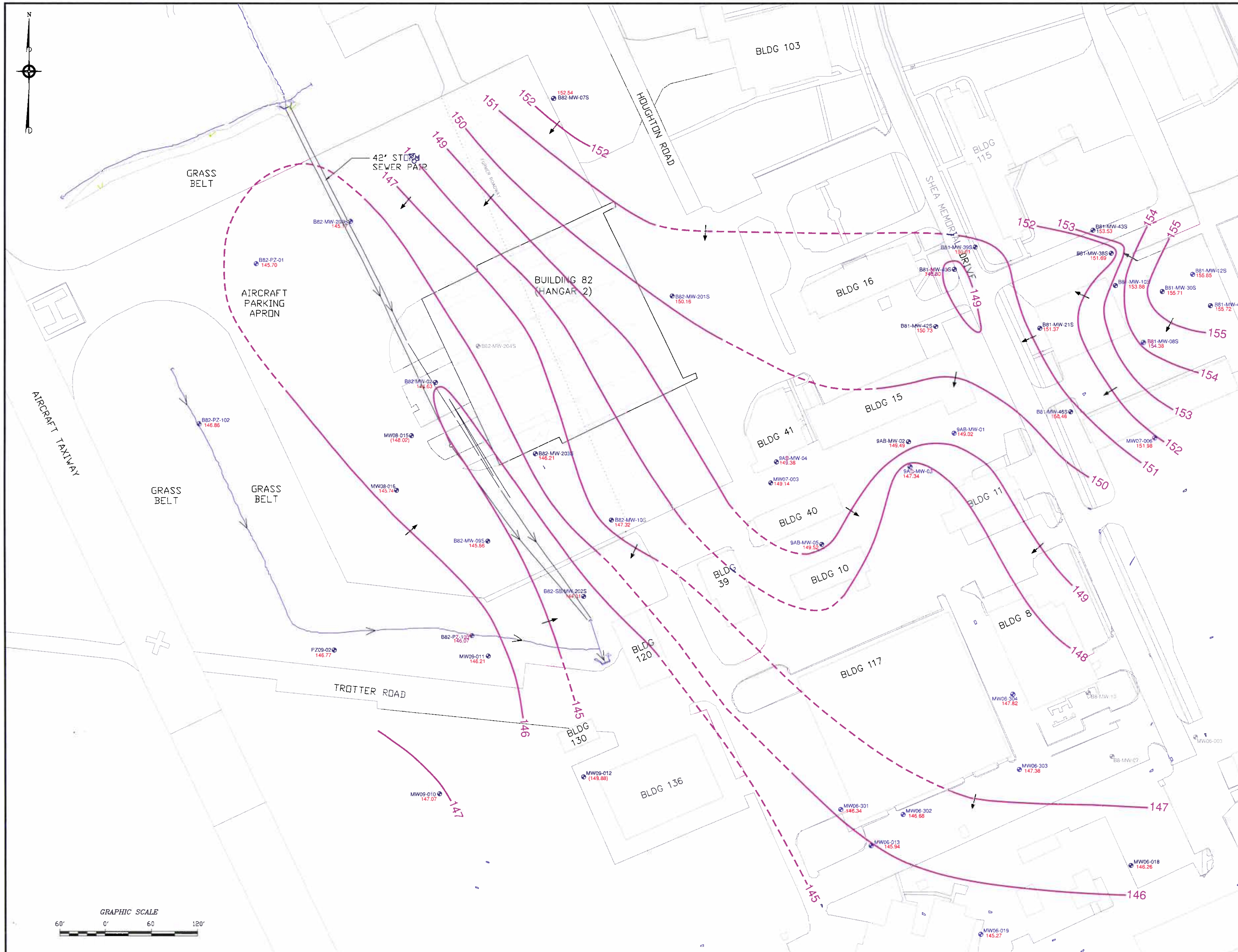
TETRA TECH NUS, INC.

DEEP OVERBURDEN GROUNDWATER CONTOUR MAP
APRIL 26, 2007
FEASIBILITY STUDY
BUILDING 82 SITE
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\DEEP_OB_CONT_042607.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-12	0	09/03/10

ACAD: \02073\FS.DF.B82\DEEP_OB_CONT_042607.DWG 09/03/10 DWM



LEGEND

B82-SB/MW-204S	MONITORING WELL USED FOR CONTOURS ON THIS FIGURE
B8-MW-07	MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE
150 — — —	GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)
149.6	MEASURED GROUNDWATER ELEVATION (FEET)
(149.2)	GROUNDWATER ELEVATION NOT CONTOURED. DATA DETERMINED TO BE INACCURATE.
←	GROUNDWATER FLOW DIRECTION

NOTES:

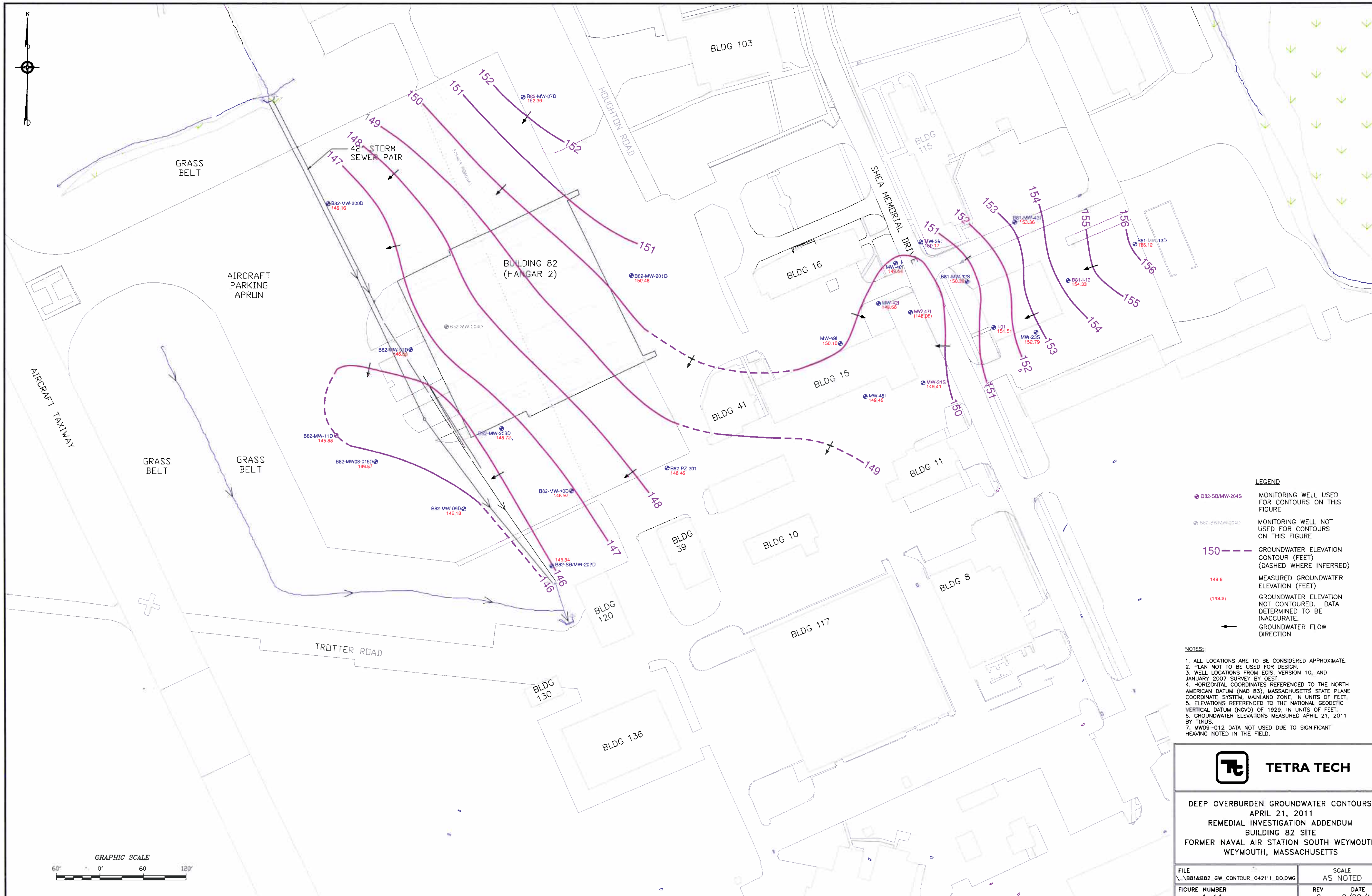
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. GROUNDWATER ELEVATIONS MEASURED APRIL 21, 2011 BY TtNUS.
7. MW09-012 DATA NOT USED DUE TO SIGNIFICANT HEAVING NOTED IN THE FIELD.

TETRA TECH

WATER TABLE GROUNDWATER CONTOURS
APRIL 21, 2011
REMEDIAL INVESTIGATION ADDENDUM
BUILDING 82 SITE
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE	
\..\B81&B82_GW_CONTOUR_042111_WT.DWG	AS NOTED	
FIGURE NUMBER	REV	DATE
1-13	0	2/29/12

ACAD: \02073\FS.FR.B82\B81&B82_GW_CONTOUR_042111_WT.DWG 2/29/12 DWM



LEGEND

B82-SB/MW-204S	MONITORING WELL USED FOR CONTOURS ON THIS FIGURE
B82-SB/MW-204D	MONITORING WELL NOT USED FOR CONTOURS ON THIS FIGURE
150 – – –	GROUNDWATER ELEVATION CONTOUR (FEET) (DASHED WHERE INFERRED)
149.6	MEASURED GROUNDWATER ELEVATION (FEET)
(149.2)	GROUNDWATER ELEVATION NOT CONTOURED. DATA DETERMINED TO BE INACCURATE.
←	GROUNDWATER FLOW DIRECTION

NOTES:

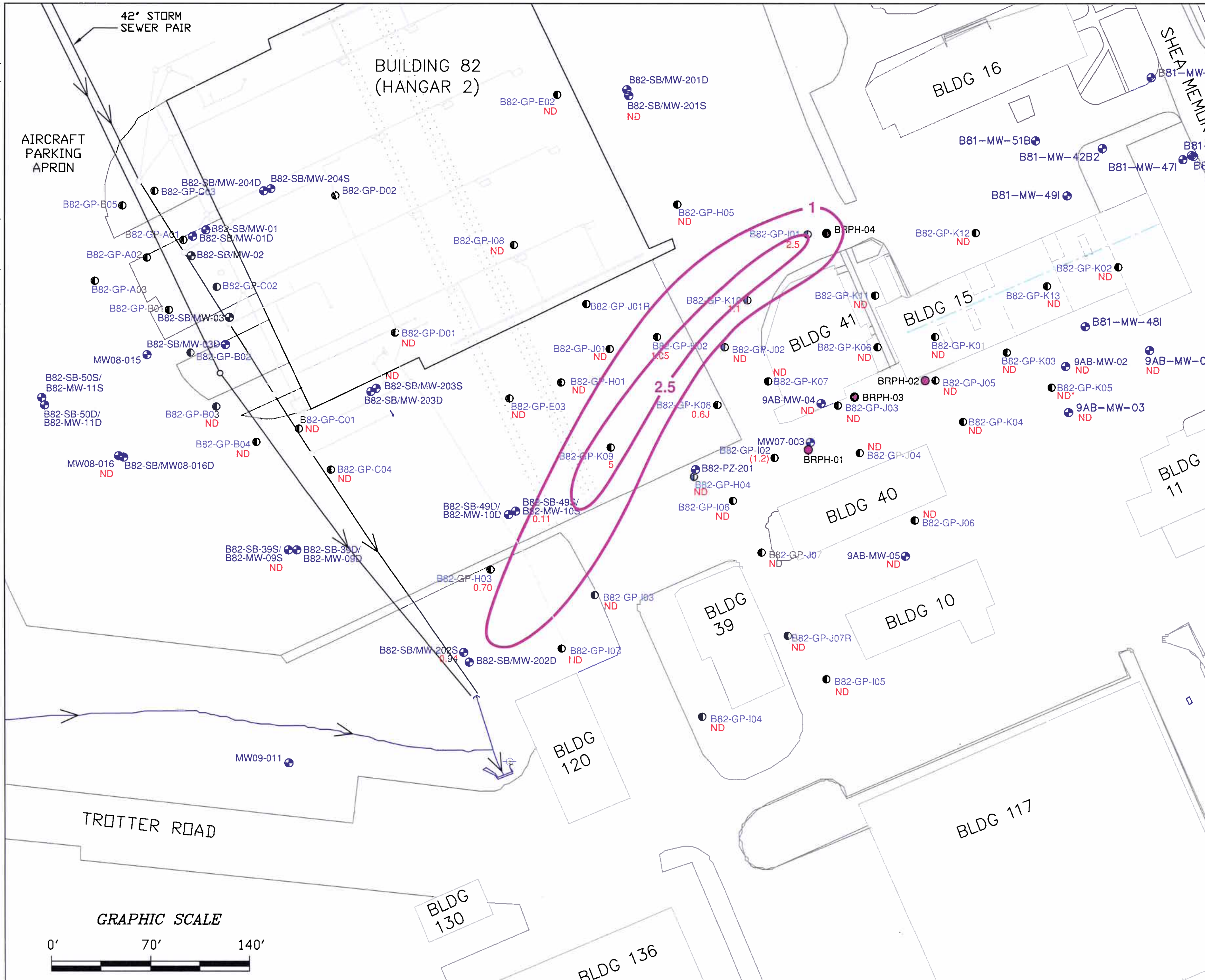
1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. GROUNDWATER ELEVATIONS MEASURED APRIL 21, 2011 BY TtNUS.
7. MW09-012 DATA NOT USED DUE TO SIGNIFICANT HEAVING NOTED IN THE FIELD.

TETRA TECH

DEEP OVERBURDEN GROUNDWATER CONTOURS
APRIL 21, 2011
REMEDIAL INVESTIGATION ADDENDUM
BUILDING 82 SITE
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE	
\..\B81&B82_GW_CONTOUR_042111_DO.DWG	AS NOTED	
FIGURE NUMBER	REV	DATE
1-14	0	2/29/12

ACAD: \02073\FS.FR.B82\B81&B82_GW_CONTOUR_042111_DO.DWG 2/29/12 DWM



LEGEND

B82-SB/MW-201D	SOIL BORING/MONITORING WELL LOCATION WITH ID
B82-GP-A03	GROUNDWATER PROFILING LOCATION WITH ID (R = REFUSAL)
BRPH-01	BEDROCK PILOT HOLES
	FLOOR DRAIN SYSTEM
	INTERIOR WALLS
5	TCE CONCENTRATION (μg/L)
(1.2)	TCE VALUE NOT CONTOURED. SAMPLED FROM 13' TO 17'. CONCENTRATION ASSUMED TO BE REPRESENTATIVE OF CONTAMINATION IN DEEP OVERBURDEN
	TCE CONTOUR
*	LOW BTEX CONCENTRATION

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR FINAL DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. FOR TRICHLOROETHYLENE THE REGION 1 PRG IS 0.028 μg/L AND THE MCL IS 5 μg/L.

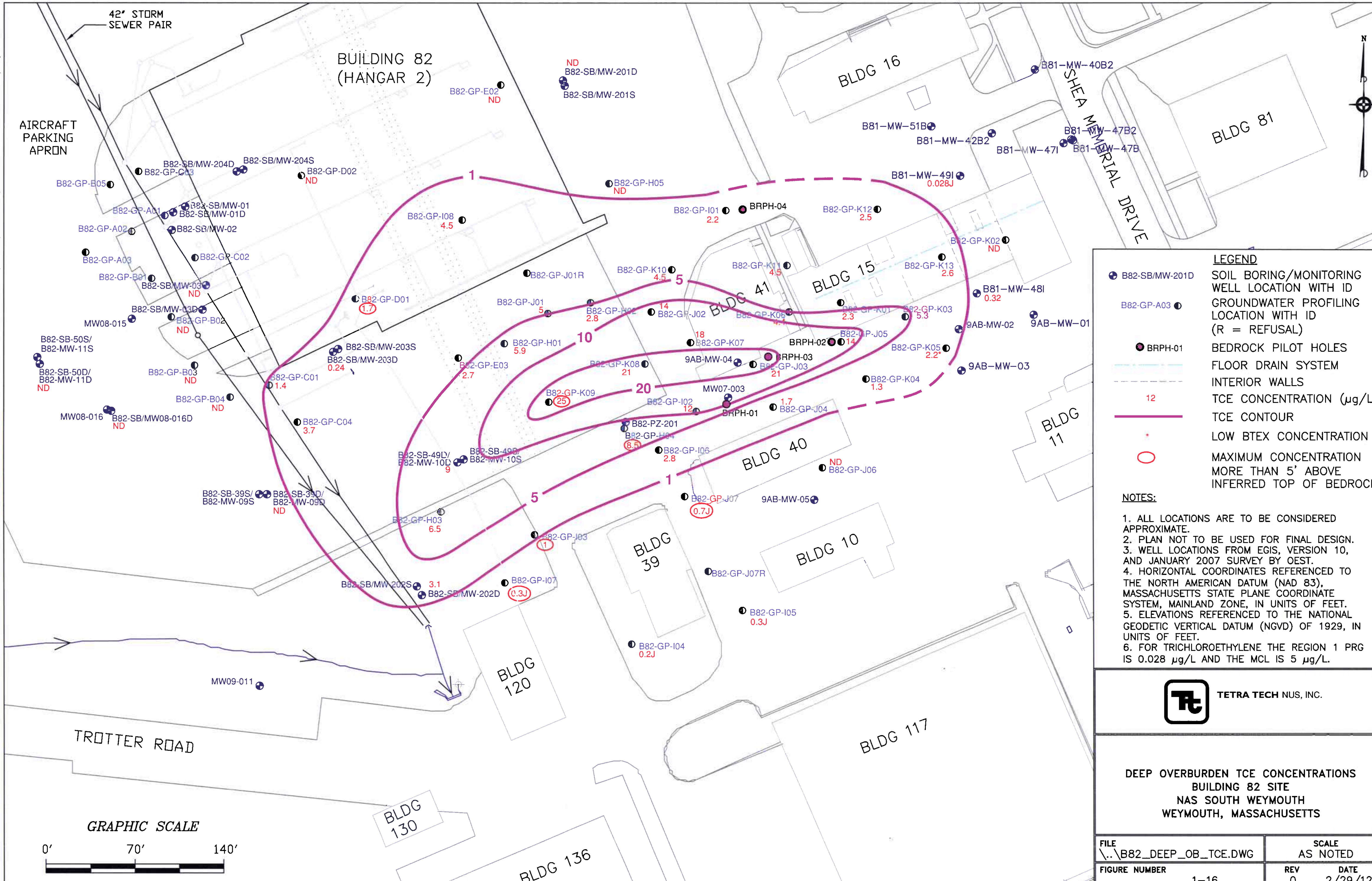
TETRA TECH

SHALLOW OVERBURDEN TCE CONCENTRATIONS
BUILDING 82 SITE
NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\B82_SHALL_OB_TCE.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-15	0	2/29/12

ACAD: I:\02073\FS.FR.B82\B82_SHALL_OB_TCE.DWG 2/29/12 DWM



LEGEND

- B82-SB/MW-201D — SOIL BORING/MONITORING WELL LOCATION WITH ID
- B82-GP-A03 — GROUNDWATER PROFILING LOCATION WITH ID (R = REFUSAL)
- BRPH-01 — BEDROCK PILOT HOLES
- FLOOR DRAIN SYSTEM
- INTERIOR WALLS
- 12 — TCE CONCENTRATION (µg/L)
- TCE CONTOUR
- LOW BTEX CONCENTRATION
- MAXIMUM CONCENTRATION MORE THAN 5' ABOVE INFERRED TOP OF BEDROCK

NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR FINAL DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. FOR TRICHLOROETHYLENE THE REGION 1 PRG IS 0.028 µg/L AND THE MCL IS 5 µg/L.

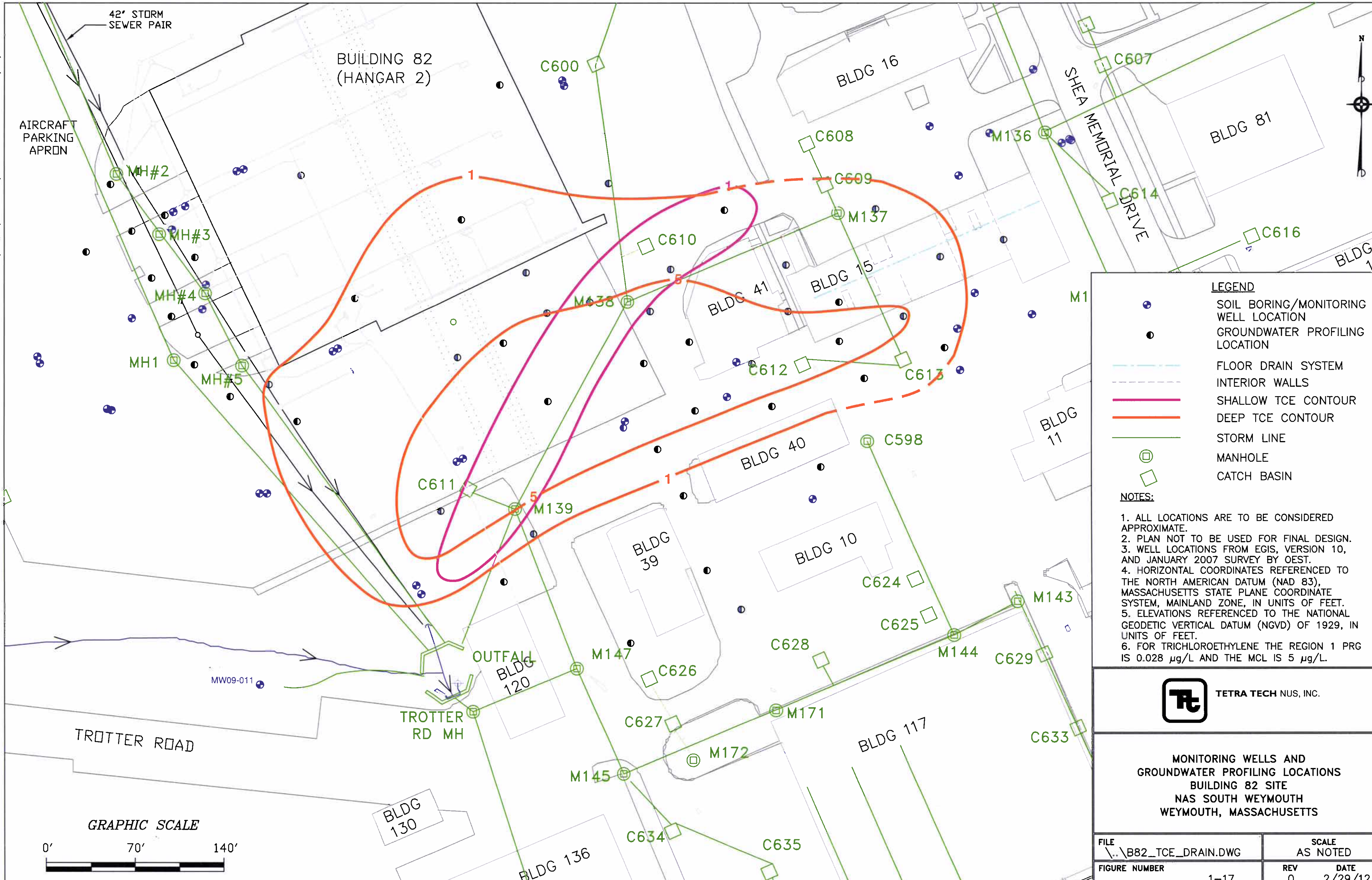
TETRA TECH NUS, INC.

DEEP OVERBURDEN TCE CONCENTRATIONS
BUILDING 82 SITE
NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\B82_DEEP_OB_TCE.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-16	0	2/29/12

ACAD:I:\02073\FS.FR.B82\B82_TCE_DRAIN.DWG 2/29/12 DWM



NOTES:

1. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
2. PLAN NOT TO BE USED FOR FINAL DESIGN.
3. WELL LOCATIONS FROM EGIS, VERSION 10, AND JANUARY 2007 SURVEY BY OEST.
4. HORIZONTAL COORDINATES REFERENCED TO THE NORTH AMERICAN DATUM (NAD 83), MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, IN UNITS OF FEET.
5. ELEVATIONS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929, IN UNITS OF FEET.
6. FOR TRICHLOROETHYLENE THE REGION 1 PRG IS 0.028 µg/L AND THE MCL IS 5 µg/L.

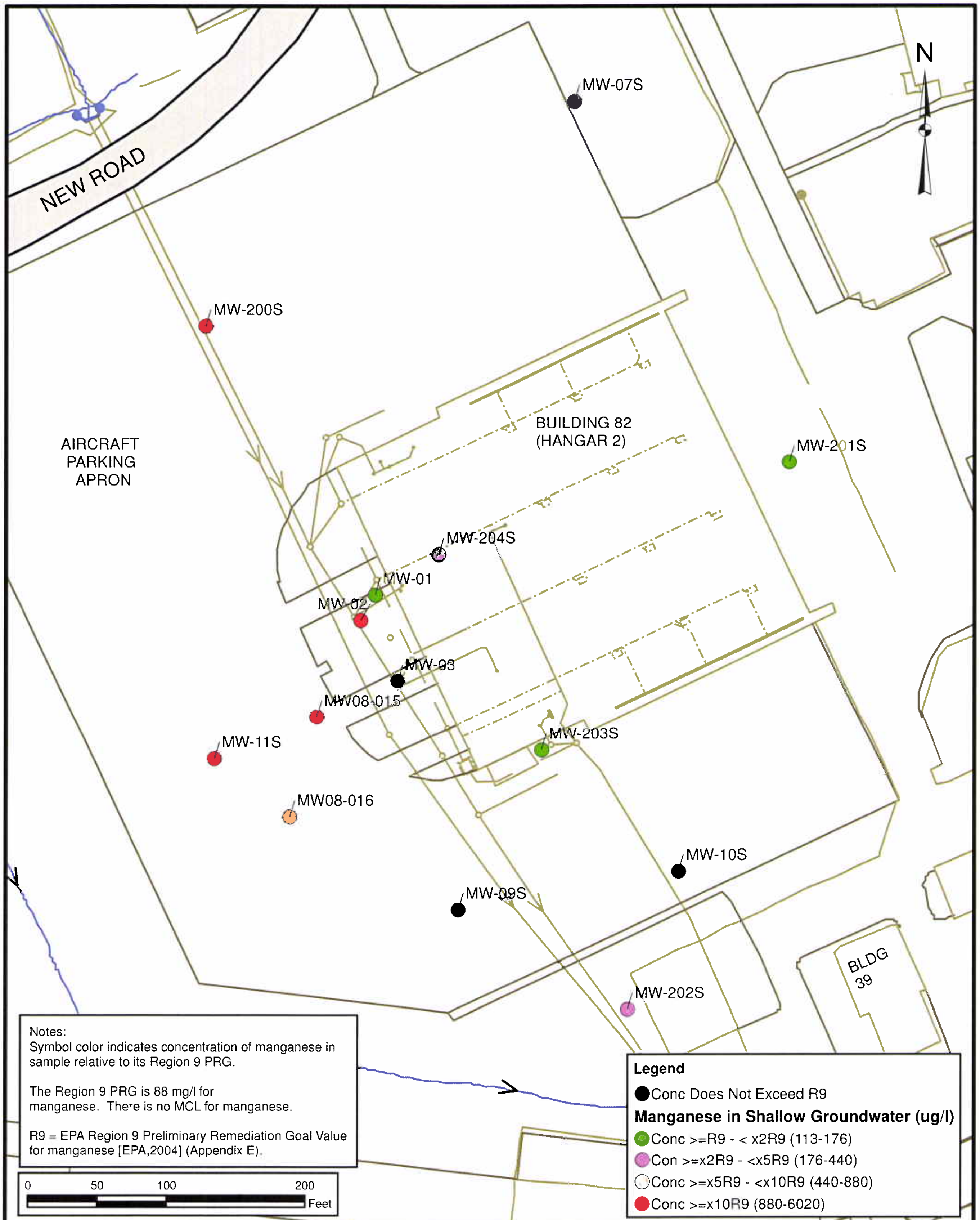
TETRA TECH NUS, INC.

MONITORING WELLS AND GROUNDWATER PROFILING LOCATIONS
BUILDING 82 SITE
NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

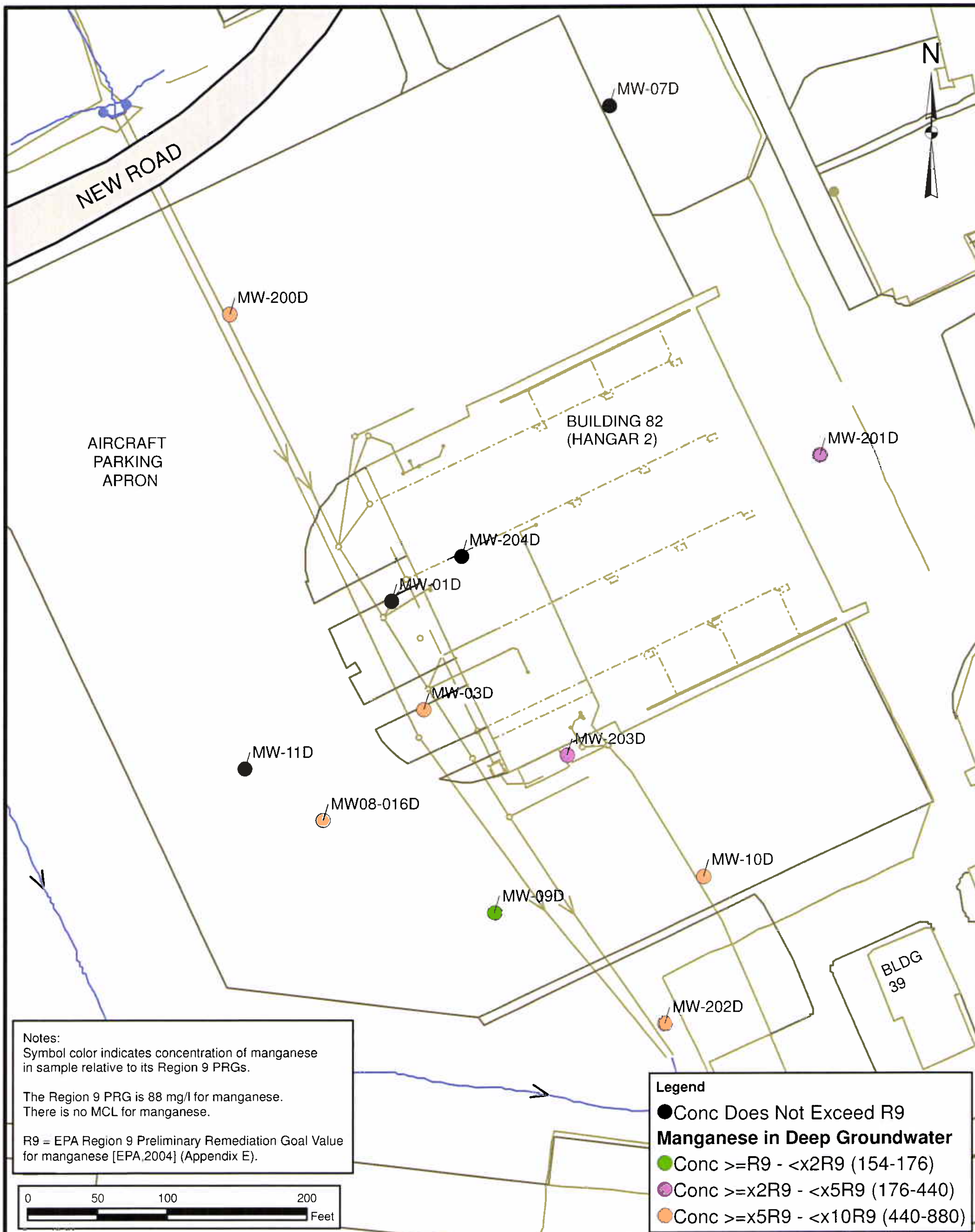
FILE	SCALE
\..\B82_TCE_DRAIN.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
1-17	0	2/29/12

I:\02073\FS FR.B82\MN_SHALLOW_GW.MXD DWM 02/29/12



Tetra Tech NUS, Inc.	COMPARATIVE LEVELS OF MANGANESE IN SHALLOW GROUNDWATER FEASIBILITY STUDY BUILDING 82 SITE NAS SOUTH WEYMOUTH WEYMOUTH, MASSACHUSETTS	SCALE AS NOTED FILE \..\MN_SHALLOW_GW.MXD REV 0 DATE 02/29/12 FIGURE NUMBER 1-18



Notes:
Symbol color indicates concentration of manganese in sample relative to its Region 9 PRGs.

The Region 9 PRG is 88 mg/l for manganese.
There is no MCL for manganese.

R9 = EPA Region 9 Preliminary Remediation Goal Value for manganese [EPA,2004] (Appendix E).

Legend

- Conc Does Not Exceed R9

Manganese in Deep Groundwater

- Conc >=R9 - <x2R9 (154-176)
- Conc >=x2R9 - <x5R9 (176-440)
- Conc >=x5R9 - <x10R9 (440-880)

Tetra Tech NUS, Inc.

COMPARATIVE LEVELS OF MANGANESE IN DEEP GROUNDWATER
FEASIBILITY STUDY
BUILDING 82 SITE
NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

SCALE	AS NOTED
FILE	\..\MN_DEEP_GW.MXD
REV	0
DATE	02/29/12
FIGURE NUMBER	1-19

2.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

This section develops RAOs and presents cleanup goals for contaminated groundwater. The regulatory requirements and guidances (e.g., ARARs) that may potentially govern remedial activities are presented in this section. In addition, this section presents COCs for remedial action and the conceptual pathways through which these chemicals may affect human health. The cleanup goals for contaminated media are developed in this section, and general response actions (GRAs) that may be suitable to achieve the cleanup goals are presented. Finally, this section presents estimates of the masses and volumes of contaminated groundwater.

2.1 MEDIA OF CONCERN

Based on the discussion in Section 1.4.1 involving risk assessment for human receptors, the media of concern at the Site was determined to be groundwater. As mentioned in Section 1.2.1 and 1.3.1, a maintenance action was performed in 2010 to further investigate areas of possible soil contamination, remove four GTMs and associated piping, and any impacted soil. Details of the work, including removals, excavation, and investigatory and confirmation sample results are included in the Final Maintenance Activities Completion Report (TtEC, 2011). A risk screening evaluation was performed using the confirmation sample data set and associated RI data. This risk screening evaluation is included as Appendix G in this FS.

Remedial action objectives and remedial alternatives will be developed in the FS for groundwater. The groundwater alternatives will be assumed to address shallow and deep groundwater in locations where COCs were identified above acceptable human health risk levels.

2.2 CHEMICALS OF CONCERN FOR REMEDIATION

Human health risk-based COCs were identified in groundwater based on the results of the RI HHRA (TtNUS, 2010). These COCs are carried forward in the FS for the development of remedial alternatives. PRGs are developed for the selected COCs in Section 2.4 of the FS.

COCs were selected based primarily on the cancer and noncancer risk estimates provided in the HHRA section of the RI Report. Initially, receptors with cumulative cancer risk estimates exceeding 1.0×10^{-5} and/or target organ/target effect specific hazard indices exceeding 1 were identified. Then the detailed cancer and non-cancer risk estimates were examined to identify the risk drivers (i.e., chemicals contributing substantially to risk). Chemicals of Potential Concern (COPCs) were selected as COCs if their Incremental Lifetime Cancer Risks (ILCRs) were greater than 1.0×10^{-6} or if the chemical-specific

HIs contributed substantially to a total receptor HI greater than 1. It should be noted that the USEPA target cancer risk range is 1.0×10^{-6} to 1.0×10^{-4}; the MassDEP cumulative cancer risk benchmark ILCR is 1.0×10^{-5}. The cumulative non-cancer risk benchmark is 1 for both the USEPA and MassDEP (calculated on a target organ/effect specific basis).

Based on the non-cancer and cancer evaluations, the following contaminants with non-cancer hazard quotients greater than 1 or with cancer risks greater than 10^{-6} in a scenario with total cancer risks greater than 10^{-4} were identified as COCs in the RI: 1,1- DCA, benzene, chloroform, TCE, PCE, N-nitroso-di-n-propylamine (NNPA), heptachlor epoxide, arsenic, and manganese in groundwater used as drinking water.

1,1,1- TCA was identified as a COC because its maximum concentration was 360 µg/L, and its MCL is 200 µg/L, although the HI is less than 1. The concentration of 1,1,1-TCA was greater than its MCL in only 1 out of 98 groundwater samples. The location of the maximum concentration of 1,1,1-TCA is the same as that of the maximum of 1,1-DCA (monitoring well B82-GP-A01). Thus, remedial actions that address 1,1-DCA will affect 1,1,1-TCA, too. Vinyl chloride, and cis-1,2-dichloroethene (DCE) (daughter products of TCE) and chloroethane (a daughter product of 1,1,1-TCA) will be retained as compounds of interest (COIs) and are considered in the development of remedial alternatives and long-term monitoring activities. Since the preceding compounds did not contribute to human health risks, they are not considered COCs.

Benzene, chloroform, PCE, heptachlor epoxide, and arsenic will be retained as COCs, though the concentrations are less than federal MCLs. The groundwater MCLs for benzene, chloroform, PCE, heptachlor epoxide, and arsenic are 5 µg/L, 80 µg/L, 5 µg/L, 0.2 µg/L, and 10 µg/L, respectively.

Manganese was also identified in the RI report as a COC in groundwater. As noted in the RI Report, concentrations of manganese in all but two groundwater samples are less than the Base background concentration. The effect of manganese on the aesthetic quality of drinking water should also be considered. The secondary drinking water standard for manganese is 50 µg/L above which the water will have a black to brown color; cause black staining, and have bitter metallic taste. The EPA Health Advisory for manganese (300 µg/L) is well above the secondary standard, so even if the shallow groundwater was considered a drinking water source, a user would have to treat the water to reduce the manganese to make the water drinkable. Therefore, even if the groundwater at the two locations where the manganese concentrations are greater than the EPA Health Advisory were treated to 300 µg/L, the groundwater would still not be drinkable. The presence of manganese above the EPA Health Advisory in groundwater will be addressed by long term monitoring and will be retained as a COC.

Two samples collected during the 2006 RI had detections of PCBs greater than the MCL. Additional groundwater sampling was conducted in October 2009 to determine if the PCB concentrations detected in the 2006 RI were related to sample turbidity and were still present at concentrations greater than the MCL. PCBs were not detected in any of the filtered and unfiltered samples collected in the 2009 supplemental RI investigation. Therefore, PCBs will not be retained as a COC. Additional monitoring will be performed to confirm that PCB concentrations are less than MCLs, as noted in subsequent sections.

No COCs were retained during the ecological risk assessment, because it was determined in the RI that the risks to terrestrial plants and invertebrates, sediment invertebrates, aquatic organisms, and terrestrial receptors at the Site were not great enough for any chemicals to warrant further evaluation of ecological risk at this Site.

Considering the above discussion, TCE, 1,1,1-TCA, 1,1-DCA, NNPA, and manganese are retained as groundwater COCs within this FS. Detections of COCs in shallow and deep groundwater are shown in Figures 2-1 and 2-2, respectively. Plume locations of the COCs are shown on Figure 2-3. Figure 2-4 shows the extent of groundwater contamination within the expanded site boundary.

2.3 REMEDIAL ACTION OBJECTIVES

Development of RAOs is an important step in the FS process. RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. The RAOs specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup goals) for the site.

There is a medium-yield aquifer beneath a portion of the Building 82 Site as shown on Figure 2-4. This aquifer is designated as an aquifer protection district in the South Shore Tri-Town Development Corporation (SSTTDC) Zoning and Land Use By-Laws for NAS South Weymouth (SSTTDC, 2005). As such, the aquifer is considered a Potential Drinking Water Source Area (PDWSA). The future uses of the former NAS South Weymouth property have been set by the Zoning and Land use By-Laws and the Reuse Plan approved in 2005. The established zoning in the area surrounding the Site is shown on Figure 2-4. The Building 82 area is located within the “Village Center District” zone. This is a mixed use zoning district including high-density housing, offices, commercial and retail. Based on the anticipated future use, alternatives that allow for the beneficial use of the PDWSA are considered in the FS.

The development of cleanup goals takes into consideration chemical-specific ARARs and TBCs). Section 2.3.2 identifies the ARARs and TBCs for groundwater remediation.

2.3.1 Statement of Remedial Action Objectives

To protect the public from potential current and future health risks, as well as to protect the environment, the following RAOs have been developed for groundwater at the Site.

Groundwater RAO No. 1: Prevent human exposure to groundwater containing concentrations of contaminants in excess of the remedial goals and that cause unacceptable risk.

Groundwater RAO No. 2: Prevent or minimize further migration of contaminants in groundwater.

Groundwater RAO No. 3: Restore groundwater quality such that there are no risks to human health preventing its permissible beneficial use.

2.3.2 ARARs and TBC Criteria

ARARs generally consist of:

Those substantive cleanup or control standards or environmental protection requirements, criteria, or limitations promulgated under other federal environmental or State environmental or facility siting laws and regulations which are either:

- Directly "Applicable" to the contaminants, proposed remedial action, location, or other circumstances found at a particular CERCLA site, or

- Are "Relevant and Appropriate" for use at a CERCLA site because they address problems or situations sufficiently similar to those encountered at the site such that their use is well suited to the site.

To qualify, all State ARARs must be identified by the State in a timely manner and must be more stringent than the equivalent federal standard, requirement, criteria, or limitation.

Per 40 CFR 300.400(g)(3), TBCs are non-promulgated, non-enforceable guidelines that may be useful for interpreting ARARs or to determine preliminary remediation goals when ARARs do not exist for a particular contaminant. Examples of TBCs include USEPA Drinking Water Health Advisories, Reference Doses (RfDs), and Cancer Slope Factors (CSFs).

2.3.2.1 Definitions

The NCP at 40 CFR 300.5 provides the following definitions for ARARs:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, although not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Per 40 CFR 300.400(g)(3), other advisories, criteria, or guidance are to be considered for a particular release. The TBC category consists of advisories, criteria, or guidance developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

Under CERCLA Section 121(d)(4), the Navy as lead agency may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control upon completion.

- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

- Compliance with the requirement is technically impracticable from an engineering perspective.

- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.

- With respect to a state requirement, the state has not consistently applied the ARAR in similar circumstances at other remedial actions within the state.

- Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Superfund money for response at other facilities (fund-balancing). This condition only applies to Superfund-financed actions.

USEPA, in various guidance documents and the NCP, has divided ARARs into three categories to facilitate identification. Chemical-specific and location-specific ARARs are identified early in the process, generally during the RI, and action-specific ARARs are normally identified during the FS in the detailed analysis of alternatives. These three types of ARARs are defined as follows:

- Chemical-Specific: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include MCLs and Clean Water Act (CWA) National Recommended Water Quality Criteria (NRWQC).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of these areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

- Action-Specific: Technology- or activity-based requirements, limitations on actions, or conditions involving special substances. Examples of action-specific ARARs include Resource Conservation and Recovery Act (RCRA) regulations for generation, characterization, and management of hazardous wastes and CWA effluent limitations and pre-treatment standards for wastewater discharges.

The following section discusses chemical- and location-specific ARARs and TBCs. Action-specific ARARs and TBCs are presented in Section 2.5.2 along with the discussion of GRAs.

2.3.2.2 Chemical-Specific ARARs and TBCs

This section presents a summary of federal and state chemical-specific ARARs and TBCs. These ARARs and TBCs provide some medium-specific guidance on “acceptable” or “permissible” concentrations of contaminants. Table 2-1 presents federal and Massachusetts chemical-specific ARARs and TBCs for this FS.

2.3.2.3 Location-Specific ARARs and TBCs

This section presents a summary of federal and state location-specific ARARs and TBCs. These ARARs and TBCs place restrictions on concentrations of contaminants or the conduct of activities based on the site's particular characteristics or location. Table 2-2 presents federal and Massachusetts location-specific ARARs and TBCs for this FS.

2.4 PRELIMINARY REMEDIATION GOALS

PRGs were developed for the Site to establish target cleanup goals for remedial actions to reduce COC concentrations in Site media and mitigate the unacceptable risks to human health and the environment. Final cleanup goals for the selected Site remedial action will be documented in the Record of Decision.

PRGs can be developed based on chemical-specific ARARs, when available, or risk-based factors. In addition, the protection of groundwater and the presence of COCs in background locations are also considered in developing the PRGs. The methods used to develop candidate PRGs are discussed below.

2.4.1 Human Health Risk-Based Preliminary Remediation Goals

Chemicals with unacceptable human health risks were identified as COCs for human receptors in Section 2.2. Human health risk-based PRGs were developed for those COCs. HHRA risk calculations are provided in Appendix B.

Risk-based PRGs are proposed cleanup levels that are based on human health risks, and are intended to be protective of human health. PRGs were derived for the COCs identified in Site soil, groundwater, surface water, and sediment. The methodology used to derive PRGs for groundwater at the Site is described below.

Potential PRGs representing human cancer risk levels of 1×10^{-4} and 1×10^{-5} and non-cancer hazard indices of 0.1 and 1 were calculated for each COC identified in Section 1.4.1 to provide risk managers with a range of options for reducing human health risks at the Site. The risk-based PRGs were calculated using exposure assumptions developed for residential exposure to Site groundwater. The PRG calculations used toxicity values, dermal exposure assumptions, chemical-specific absorption factors, and dermal intake equations consistent with current EPA HHRA guidance. The residential exposure scenario is more conservative than other scenarios considered at the Site (on-site workers, trespassers, construction workers, or recreational visitors). As a result, the PRGs calculated for the residential scenario are protective for future residents as well as on-site workers, trespassers, construction workers, and recreational visitors.

Note that the risk assessment in the RI determined that there were no vapor intrusion risks. Risks were not recalculated as part of the RI Addendum since the concentrations detected during the supplemental investigations were similar to those observed in the RI.

Table 2-3 presents the range of potential cancer and non-cancer risk-based PRGs for human health COCs and COIs. An evaluation of the protectiveness of the potential PRGs was performed and the lower of the values representing the 10^{-5} cancer risk level and an HQ of 1.0 for each COC was selected as the human health risk-based PRG. These selected human health risk-based PRGs represent values protective of both cancer and non-cancer risks. Once the PRGs have been achieved, the human health risk will be calculated using the groundwater monitoring data to determine whether the concentrations result in excess human health risk.

2.4.2 ARARs and TBCs

Federal and state MCLs and non-zero MCLGs have been identified as chemical-specific ARARs for Site groundwater. The MCLs are promulgated, legally enforceable standards for drinking water. Because a portion of the Site is underlain by a mapped potentially productive medium-yield aquifer, which is designated as an aquifer protection district and considered to be a PDWSA, available MCLs and non-zero MCLGs were considered in selection of PRGs for groundwater. These values are shown in Table 2-4.

Massachusetts also has default risk-screening criteria (e.g., GW-1) for groundwater under the MCP (310 CMR 40.0974). Those values are not considered to be ARARs or TBCs under CERCLA because they do not apply outside the context of an MCP Method 1 (i.e., non site-specific) risk characterization approach. The MCP itself excludes the use of default risk-screening criteria (i.e., Method 1 groundwater standards) when a site-specific risk characterization approach is applied, such as an MCP Method 3 risk characterization or a CERCLA risk assessment. As summarized in Section 1.3, the Navy has completed CERCLA risk assessments for the Site. Therefore, the Navy has developed site-specific risk-based cleanup goals (Section 2.2) rather than using MCP screening values.

2.4.3 Background Concentrations

Background concentrations may be used as PRGs, since background values represent contaminant concentrations in the absence of Site activities when no excess risk is anticipated. Background concentrations are used in selection of PRGs because it is not reasonable and may not be possible to remediate Site media to concentrations that are lower than background conditions. Further, it is Navy policy to only address those risks associated with chemical concentrations that are elevated as a result of a site-related release.

Background concentrations were developed for NAS South Weymouth, for use in the EBS and RI programs, in the Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, February 2000) and the Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, November 2002). In these reports, background data from the EBS and RI programs were combined together to develop site-wide soil and sediment background level contaminant concentrations. As agreed by the Navy, EPA and MassDEP, the 95 percent Upper Prediction Limit (UPL) for each detected analyte in the NAS South Weymouth background dataset would be used as site-wide background concentrations. The initial report (February 2000) included UPLs only for those analytes whose concentrations at any EBS RIA exceeded the EBS Program screening criteria at that time. Subsequently, additional sampling was conducted and it was determined that background concentrations were needed for additional compounds. The Supplemental Report was prepared to calculate 95 percent UPLs for all analytes detected in the background data set. The 95 percent UPL background values were used as potential PRGs for the groundwater COCs and COIs identified at the Site and are also shown on Table 2-4.

2.4.4 Selection of Proposed PRGs

The human health risk-based PRGs were used along with available ARARs, TBCs, and basewide background concentrations to select proposed PRGs for each COC. The selected PRGs are the COC concentrations that would provide the highest level of protection of human health and the environment, while still being reasonably achievable by current remediation techniques. The rationale for selection of PRGs for groundwater, the medium of concern for the Site, is described below. Table 2-4 presents the potential and selected PRGs for each compound and the basis for selection.

The PRGs must be protective of the current and anticipated future receptors identified at the site, and they should be reasonable and practical to implement. PRGs can be developed based on chemical-specific ARARs, when available, or risk-based factors. In addition, the protection of groundwater and the presence of COCs and COIs in background locations are also considered in developing the PRGs.

For groundwater, the PRGs were selected from ARARs (MCLs or non-zero MCLGs), if available, since these are legally enforceable standards. If an MCL or non-zero MCLG was not available, or if an ARAR alone would not be sufficiently protective in the given circumstances, the value representing the 10^{-5} cancer risk level or HI equal to 1 were selected as the PRG. TCE and 1,1,1-TCA are the only groundwater COCs that have an available ARAR, the MCL (5 µg/L and 200 µg/L, respectively). The MCL was selected as the PRG because it is considered to be sufficiently protective given site-specific circumstances. The selected groundwater PRGs for 1,1-DCA (70 µg/L) and NNPA (0.073 µg/L) are human health risk-based values. There are no established Base background values for TCE, NNPA, and 1,1-DCA. The EPA Health Advisory for manganese, 300 µg/L, will be used as the manganese PRG.

The potential PRG values for groundwater are summarized in Table 2-4, which includes the selected PRGs for each COC and COI and the rationale for the selection. Table 2-5 provides a comparison of site data with the proposed PRGs.

2.5 GENERAL RESPONSE ACTIONS AND ACTION-SPECIFIC ARARS

GRAs describe categories of actions that could be implemented to satisfy or address a component of an RAO for the site. Remedial action alternatives will then be developed using GRAs individually or in combination to meet RAOs. The remedial action alternatives, composed of GRAs, will be capable of achieving the RAOs for groundwater above PRGs at the Site.

2.5.1 General Response Actions

GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial action alternatives are formed using GRAs singly or in combination to meet the RAOs.

The following GRAs will be considered for groundwater:

- No Action
- Limited Action
- Removal with Ex-Situ Treatment and Discharge
- In-Situ Treatment

2.5.2 Action-Specific ARARs

Action-specific ARARs and TBC criteria are technology- or activity-based regulatory requirements or guidance that would control or restrict a remedial action. The federal and State of Massachusetts action-specific ARARs and TBCs for each alternative are presented in Section 4.

2.6 ESTIMATED VOLUME AND MASS OF CONTAMINATED GROUNDWATER

The mass and volume of contaminants in groundwater as dissolved- and absorbed-phase were estimated using RI data. Partition coefficients were obtained from literature, and the value for organic carbon in the soil was estimated using data collected during the RI. The volume and mass of contaminants is summarized in Table 2-6. The calculations are included in Appendix C.

2.6.1 Contaminated Shallow Groundwater Volume and Mass

One location (GP-KO9) was identified in shallow groundwater to have a TCE concentration in excess of the TCE MCL (5 µg/L). 1,1-DCA was detected in shallow groundwater at a maximum concentration (99 µg/L) slightly exceeding the PRG of 70 µg/L at one location, GP-A01. 1,1,1-TCA was detected at its maximum concentration at the same location. The NNPA PRG (0.0073 µg/L) was exceeded in shallow groundwater at MW-200S. Therefore, for FS purposes, it is assumed that remedial action is required at three separate areas for each of the shallow groundwater COCs.

The following describes the area, volume, and mass associated with each shallow COC plume:

- TCE: As noted in Section 1.3.2, a plume (defined by the half the MCL of 5 µg/L) surrounding GP-K09 was further delineated during the RI Addendum and was assumed to have an area of 4,600 square feet (ft^2) and a thickness of 20 feet. Using a porosity of 0.25 for shallow groundwater, the estimated volume of TCE-impacted shallow groundwater is 173,000 gallons. The estimated dissolved- and sorbed-phase masses of TCE within shallow groundwater are 0.005 and 0.012 pounds, respectively.

- 1,1,1-TCA and 1,1-DCA: A plume (defined by an isoconcentration line of 50 µg/L 1,1-DCA) surrounding GP-A01 was assumed to have an area of 300 ft^2 and a thickness of 10 feet. The maximum concentration of 1,1-DCA of 99 µg/L is slightly greater than the PRG of 70 µg/L, so a contour of approximately 50 µg/L was selected for the purposes of estimating areas for treatment. The concentration of 1,1,1-TCA is assumed to be less than 200 µg/L at this contour, too. Using a porosity of 0.25 for shallow groundwater, the estimated volume of 1,1,1-TCA and 1,1-DCA-impacted shallow groundwater is 6,000 gallons. The estimated dissolved and sorbed-phase masses of 1,1,1-TCA within shallow groundwater are 0.013 and 0.025 pounds, respectively. The estimated dissolved- and sorbed-phase masses of 1,1-DCA are 0.0035 and 0.0014 pounds, respectively.

- NNPA: A plume (defined by the PRG of 0.073 µg/L) surrounding GP-A01 (NNPA maximum concentration of 0.29 µg/L) was assumed to have an area of 300 ft^2 and a thickness of 10 feet. Using a porosity of 0.25 for shallow groundwater, the estimated volume of NNPA-impacted shallow groundwater is 6,000 gallons. The estimated dissolved- and sorbed-phase masses of NNPA within shallow groundwater are 7.3×10^{-6} and 1.2×10^{-5} pounds, respectively.

2.6.2 Contaminated Deep Groundwater Volume and Mass

Thirteen locations were identified in deep groundwater to have TCE concentrations greater than the TCE MCL (5 µg/L) within a single plume. Therefore, for FS purposes, it is assumed that remedial action is required at one area for the deep groundwater COC (TCE).

The following describes the area, volume, and mass associated with the TCE COC plume:

- <u>TCE</u>: A plume (defined by MCL of 5 µg/L) surrounding MW-10D, GP-H01, GP-H03, GP-H04, GP-I02, GP-J01, GP-J02, GP-J03, GP-J05, GP-K03, GP-K07, GP-K08, and GP-K09 was assumed to have an area of 40,200 ft^2 and a thickness of 20 feet. Using a porosity of 0.20 for deep groundwater, the estimated volume of TCE-impacted deep groundwater is 1,203,000 gallons. The estimated dissolved- and sorbed-phase masses of TCE within deep groundwater are 0.11 and 0.31 pounds, respectively.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	TBC	Guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Would be considered for development of human health protection cleanup goals for groundwater at this site.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance values used to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Would be considered for development of human health protection cleanup goals for groundwater at this site.
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Would be considered for development of human health protection cleanup goals for groundwater at this site.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Would be considered for development of human health protection cleanup goals for groundwater at this site.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 U.S.C. § 300f *et seq.;* 40 C.F.R. 141, Subpart G	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	MCLs are relevant and appropriate to drinking water aquifers and will be evaluated during development of PRGs.

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs)	42 U.S.C. § 300f *et seq.;* 40 C.F.R. 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only.	Establishes MCLGs for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	MCLs are relevant and appropriate to drinking water aquifers and will be evaluated during development of PRGs.
Drinking Water Health Advisory for Manganese (EPA Office of Drinking Water)	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants in groundwater that may be used for drinking water where the standard is more conservative than either federal or state statutory or regulatory standards. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	Would be considered for development of human health protection cleanup goals for groundwater at this site.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establishes enforceable MCLs as standards for public drinking water systems. Used as cleanup standards for aquifers that are potentially drinking water supplies. Established MCLGs which are non-enforceable health goals for public drinking water systems.	Massachusetts MCLs will be evaluated during the development of PRGs for groundwater.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	TBC	Establishes enforceable water quality standards for surface water.	Would be considered for monitoring to provide protection of surface water as a receptor to COCs in groundwater.

TABLE 2-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State				
Massachusetts Endangered Species Act	321 CMR 10.00	Relevant and Appropriate	Prohibits the taking of any plants or animals listed as Endangered, Threatened, or special Concern by the Massachusetts Division of Fisheries and Wildlife and protects endangered/threatened species populations.	No state-listed endangered species have been identified at the Base. Appropriate measures must be taken during remedial actions to ensure that endangered or threatened migratory birds that may pass through the area are protected. State-listed species of special concern (Eastern Box Turtle) have been observed at the base, but not at the Building 82 site.

TABLE 2-3

SELECTION OF HUMAN HEALTH RISK-BASED PRGS
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Contaminant of Concern	Units	Cancer Risk-Based[1]		Non-Cancer Risk-Based[2]	Proposed Human Health Risk-Based PRG[3]	Selection Basis
		PRG based on CR=10-6	PRG based on CR=10-5	PRG based on HI=1		
Groundwater						
1,1-DCA	µg/L	2.4	24	2,900	24	cancer risk
NNPA	µg/L	0.0093	0.093	NA	0.093	cancer risk
TCE	µg/L	0.72	7.2	4.7	4.7	noncancer risk
Manganese	µg/L	NA	NA	320	320	noncancer risk
1,1,1-TCA	µg/L	NA	NA	7,500	7,500	noncancer risk
cis-1,2-DCE [4]	µg/L	NA	NA	28	28	noncancer risk
Vinyl chloride [4]	µg/L	0.015	0.15	36	0.15	cancer risk
Arsenic[5]	µg/L	0.038	0.38	3.1	0.38	cancer risk
Benzene[5]	µg/L	0.27	2.7	38	2.7	cancer risk
Chloroform[5]	µg/L	0.49	4.9	99	4.9	cancer risk
PCE[5]	µg/L	5.4	54	45	45	noncancer risk
Heptaclor Epoxide[5]	µg/L	0.0027	0.027	0.07	0.027	cancer risk

1. Human health risk-based PRG based on cancer risk (CR) of $1x10^{-5}$ and $1x10^{-6}$.
2. Human health risk-based PRGs based on hazard index (HI) of 1 for non-carcinogenic effects.
3. Proposed human health risk-based PRG is the lower of the values for HI=1 and $CR=10^{-5}$.
4. Compound of Interest. Note that chloroethane is also a daughter product of TCA. However there are no cancer or non-cancer risk-based values for this chemical.
5. Concentrations of these COCs were less than MCLs.

CR - Cancer risk.
HI - Hazard Index.
NNPA - n-nitroso-di-n-propylamine.
PRG - Preliminary Remediation Goal.
DCA - Dichloroethane.
DCE - Dichloroethene
TCA - Trichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene
µg/L - Micrograms per liter.

TABLE 2-4

SELECTION OF PRGs
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Contaminant of Concern	Units	Risk-Based PRG[1]	Federal ARAR/TBC[2]	MMCL/ORSG[3]	95% UPL Background Concentrations[4]	Selected PRG[5]	Selection Basis[6]
Groundwater							
1,1-DCA	µg/L	24	NA	70	NA	70	ARAR-Mass MCL
NNPA	µg/L	0.093	NA	NA	NA	0.073	HH PRG
TCE	µg/L	4.7	5/0	5	NA	5	ARAR-MCL
Manganese	µg/L	320	300 [8]	NA	2,680	300	ARAR-Health Advisory
1,1,1-TCA	µg/L	7,500	200/200	200	NA	200	ARAR-MCL/MCLG
cis-1,2-DCE [7]	µg/L	28	70/70	70	NA	70	ARAR-MCL/MCLG
Vinyl chloride [7]	µg/L	0.15	2	2	NA	2	ARAR-MCL
Arsenic[10]	µg/L	0.38	10	10	NA	10	ARAR-MCL
Benzene[10]	µg/L	2.7	5	5	NA	5	ARAR-MCL
Chloroform[10]	µg/L	4.9	80[9]/70	70 (ORSG)	NA	70	ARAR-MCLG
PCE[10]	µg/L	45	5	5	NA	5	ARAR-MCL
Heptachlor Expoxide[10]	µg/L	0.027	0.2	0.2	NA	0.2	ARAR-MCL

NOTES:

1. From Table 2-3.
2. Available ARARs/TBCs (Applicable or Relevant and Appropriate Requirements/To Be Considered criteria). MCL/MCLG
3. MMCL = Massachusetts Drinking Water Guidelines, 310 CMR 22. ORSG = Office of Research and Standards Guideline.
4. 95% Upper Prediction Limit (UPL) Background Concentrations - Basewide background concentrations calculated in the Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, February 2000) and the Supplement to the Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, November 2002).
5. PRG selection rationale: Selected PRG is the ARAR (if available and sufficiently protective) or the lowest of the risk-based values.
6. Selection Basis:
   HH - Human health risk.
   Bkgd - background concentration.
   ARAR - Applicable or Relevant and Appropriate Requirement.
   MCL - Maximum Contaminant Level.
   MCLG - Maximum Contaminant Level Goal.
7. Compound of Interest. Note that chloroethane is also a daughter product of TCA. However there are no cancer or non-cancer risk-based values to develop a PRG for this chemical.
8. USEPA Drinking Water Health Advisory, 2004
9. MCL for Total Trihalomethanes.
10. Concentrations of these COCs were less than MCLs.

NNPA - n-nitroso-di-n-propylamine
PRG - Preliminary Remediation Goal
DCA - Dichloroethane
DCE - Dichloroethene
TCA - Trichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene
µg/L - micrograms per liter

TABLE 2-5

COMPARISON OF SITE DATA WITH PROPOSED PRGS
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Contaminant of Concern	Max. Detected Value, µg/L	Selected PRG[1], µg/L	No. Samples Exceeding PRGs	Locations Exceeding PRGs
Groundwater				
1,1-DCA	99	70	1	GP-A01
NNPA	0.29	0.073	1	MW-200S
TCE	25	5	14	Shallow Plume : GP-K09 Deep Plume: GP-J02, GP-J01, GP-H01, GP-K09, GP-H04, MW-10D, GP-H03, GP-I02, GP-K08, GP-J03, GP-J05, GP-K03, and GP-K07
Manganese	6,020	300	12	MW-02, MW-08, MW-11S, MW-200S, MW-202S, MW-204S, MW-03D, MW-08D, MW-10D, MW-200D, MW-201D, MW-202D
1,1,1-TCA	360	200	1	GP-A01
cis-1,2-DCE [2]	1.3	70	0	Not Applicable
Vinyl chloride [2]	ND	2	0	Not Applicable
Arsenic	5.32	10	0	Not Applicable
Benzene	1.3	5	0	Not Applicable
Chloroform	4.6	70	0	Not Applicable
PCE	0.4	5	0	Not Applicable
Heptachlor Epoxide	0.02	0.2	0	Not Applicable

NOTES:
1 - See Table 2-4 for details of PRG selection process.
2 - Compound of Interest. Note that chloroethane is also a daughter product of TCA. However there are no cancer or non-cancer risk-based values to develop a PRG for this chemical.
DCA - Dichloroethane
DCE - Dichloroethene
ND - Not detected

TABLE 2-6

ESTIMATED MASS OF COCs IN GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

COC	Dissolved Phase (pounds)	Sorbed Phase (pounds)	Total (pounds)
TCE			
TCE (shallow groundwater, within 2.5 µg/l plume)	0.005	0.012	0.017
TCE (deep groundwater, within 5 µg/l plume)	0.109	0.307	0.416
TCE (total)	0.116	0.319	0.436
1,1-DCA - within assumed 50 µg/L plume			
1,1-DCA (shallow groundwater)	0.0035	0.0014	0.0049
1,1,1-TCA - within assumed 200 µg/L plume			
1,1,1-TCA (shallow groundwater)	0.013	0.025	0.038
NNPA - within assumed 0.073 µg/L plume			
NNPA (shallow groundwater)	7.0×10^{-6}	1.3×10^{-5}	2.0×10^{-5}

µg/L - micrograms per liter.
COC - Chemical of concern.
TCE - Trichloroethene.
NNPA - N-nitroso-di-n-propylamine.
DCA - Dichloroethane.
TCA - Trichloroethane.

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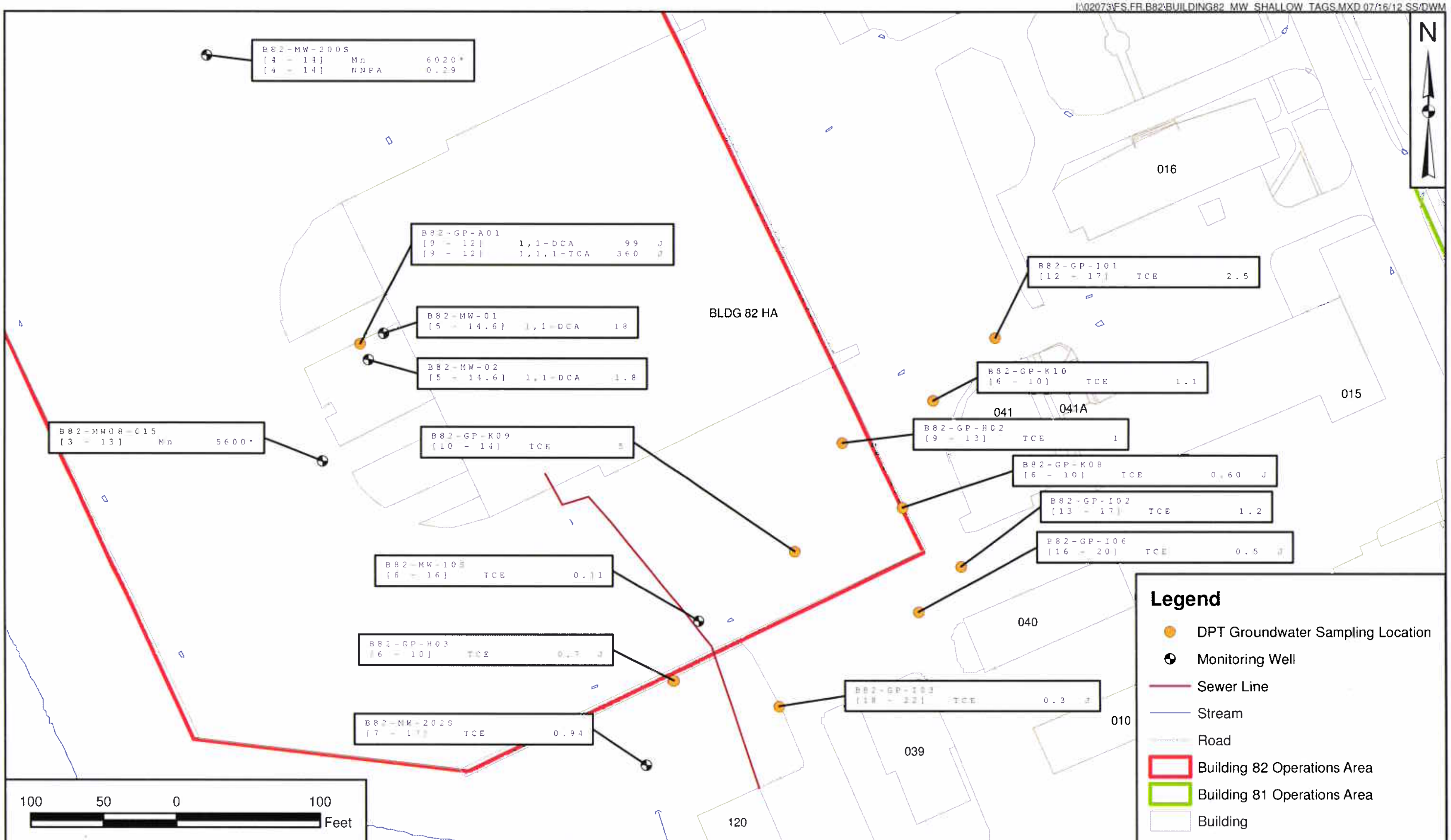

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J. LOGAN	9/16/10
REVISED BY	DATE
D. MACDOUGALL	7/16/12
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TETRA TECH

COC CONCENTRATIONS
IN SHALLOW GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

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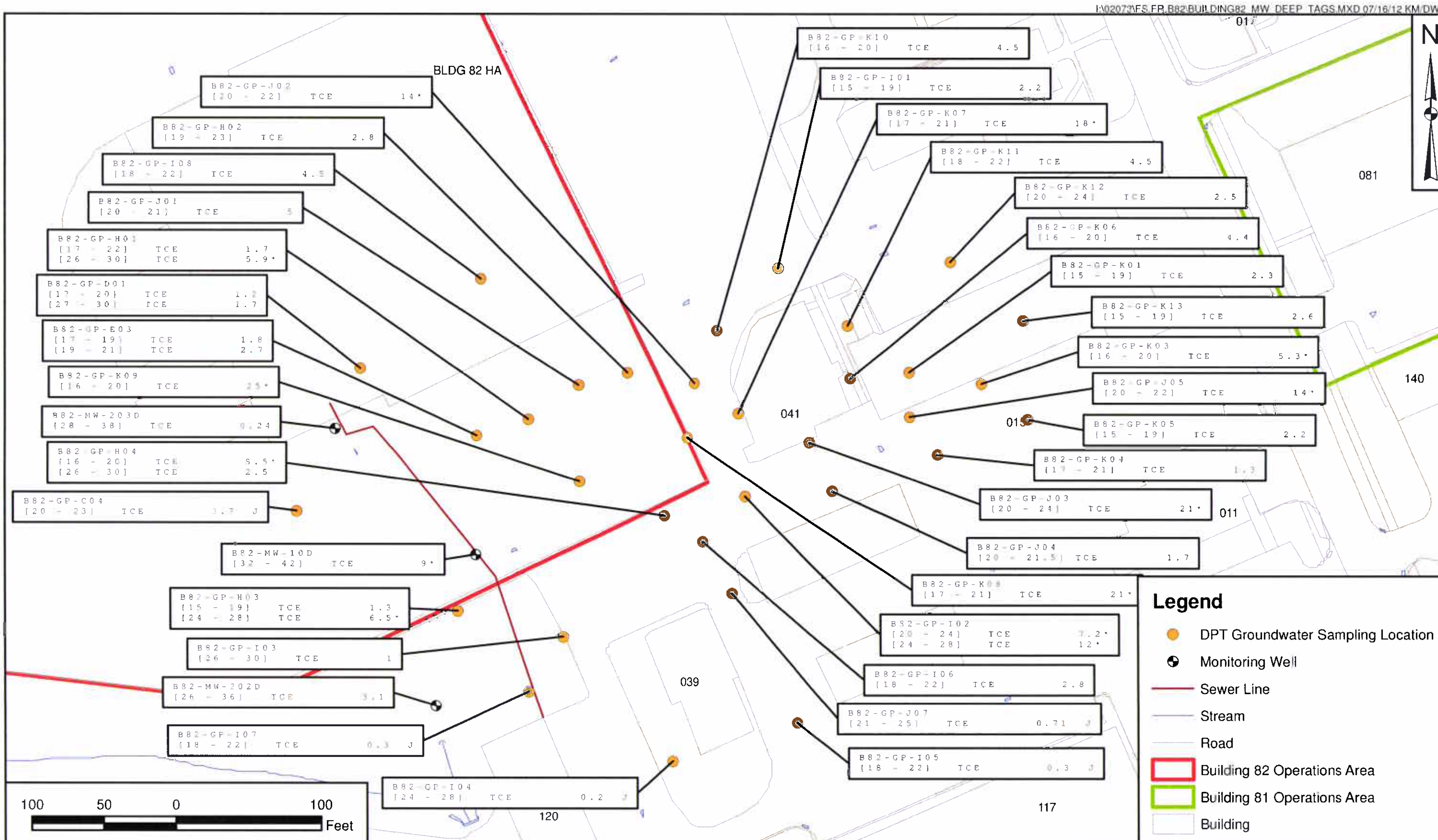
FIGURE 2-1	



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CHECKED BY C. HOOK	DATE 9/8/10
REVISED BY D. MACDOUGALL	DATE 7/16/12
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TETRA TECH

COC CONCENTRATIONS
IN DEEP GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

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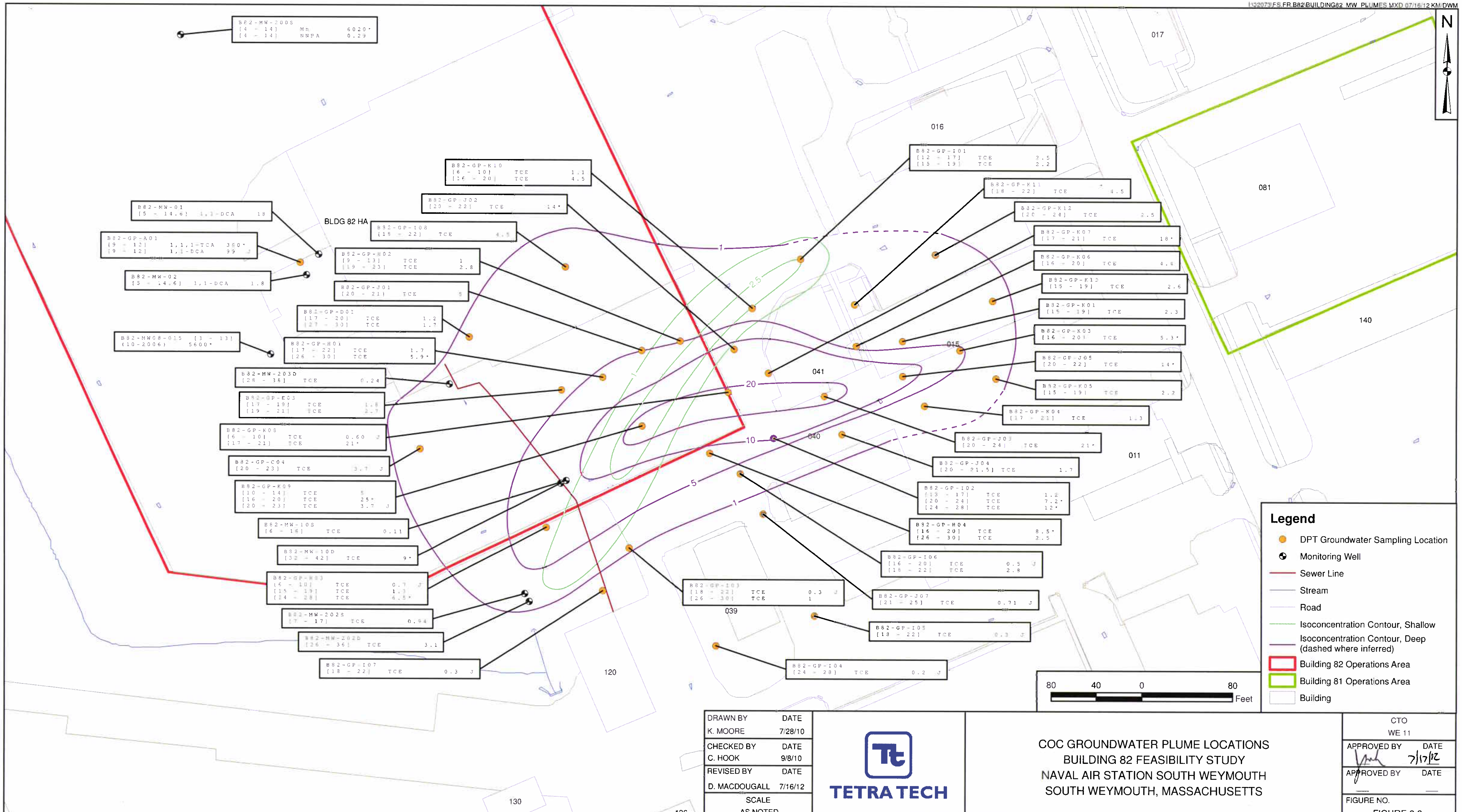
FIGURE NO. FIGURE 2-2	



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REVISED BY D. MACDOUGALL	DATE 7/16/12	
SCALE AS NOTED		

COC GROUNDWATER PLUME LOCATIONS
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

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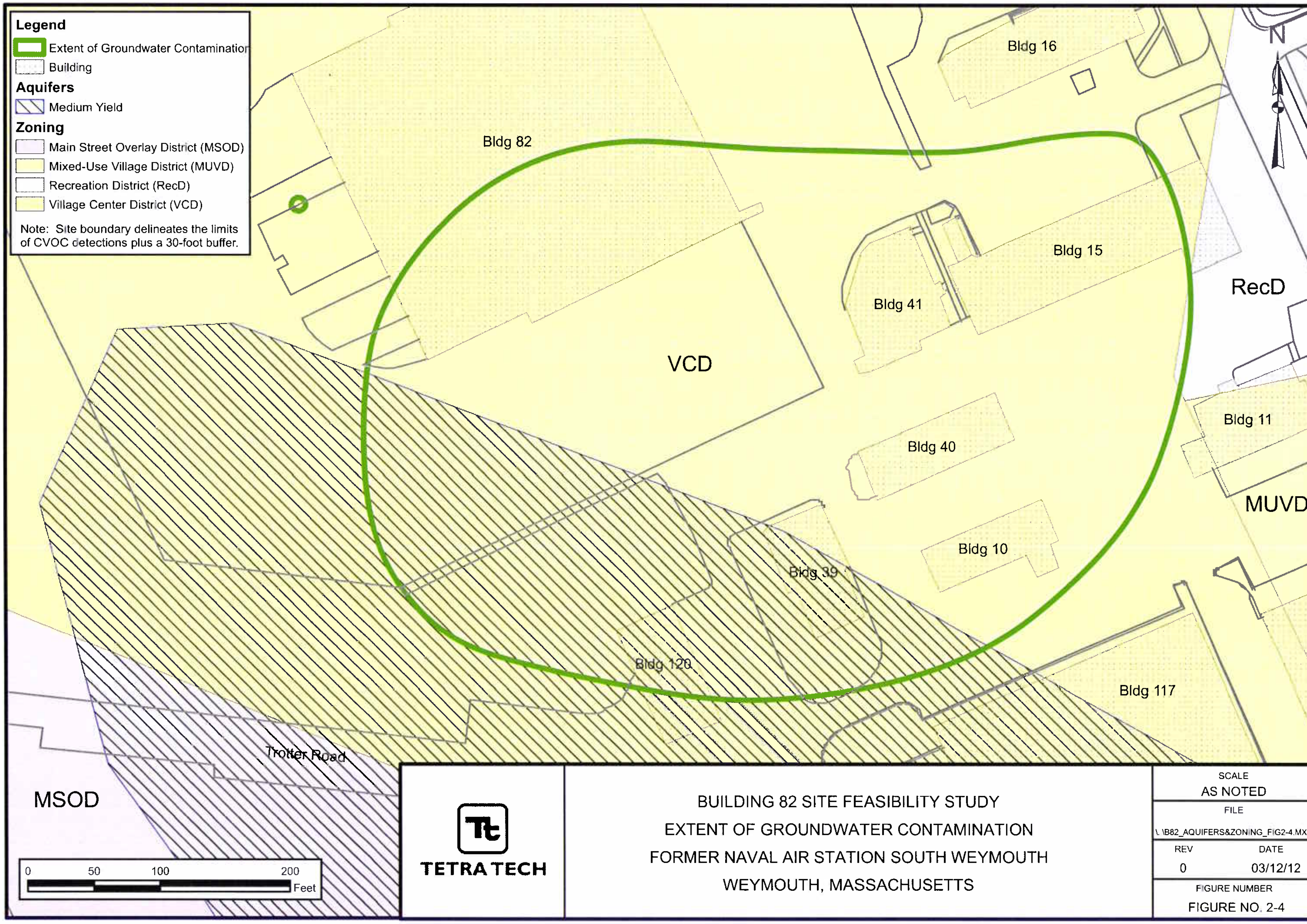

TETRA TECH

BUILDING 82 SITE FEASIBILITY STUDY
EXTENT OF GROUNDWATER CONTAMINATION
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential technologies and process options that may be applicable to the remedial alternatives for the Building 82 site. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options to be used for developing the remedial alternatives.

The basis for technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Identification of ARARs
- Development of RAOs and PRGs
- Identification of GRAs
- Development of estimated areas and volumes of contaminated soil and groundwater

Technology screening evaluation is performed in this section with the completion of the following analytical steps:

- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

A variety of technologies and process options are identified under each GRA (identified in Section 2.5.1) and screened. The selection of technologies and process options for initial screening is based on the Guidance for Conducting Remedial Investigations/Feasibility Studies under CERCLA (USEPA, 1988). The screening is first conducted at a preliminary level to focus on relevant technologies and process options, and then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
  - Protection of human health and the environment; reduction in toxicity, mobility, or volume; and permanence of the solution.
  - Ability of the technology to address the estimated areas or volumes of the contaminated media.
  - Ability of the technology to attain the PRGs required to meet the RAOs.
  - Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term maintenance and operation requirements.

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

Technologies and process options will be identified in the following sections.

3.1 PRELIMINARY SCREENING OF GROUNDWATER REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens remediation technologies and process options for groundwater at a preliminary stage based on implementation with respect to site-specific conditions and COCs. Table 3-1 summarizes the results of this preliminary screening process. It presents the GRAs, identifies the technologies and process options, and provides a brief description of each process option followed by comments about the results of the screening process.

The following are the groundwater technologies and process options remaining for detailed screening.

General Response Action	Technology	Process Option
No Action	None	Not applicable
Limited Action	Institutional Controls	Passive controls; restrictions on groundwater use
	Monitoring	Sampling and analysis
	Natural Attenuation	Naturally occurring biodegradation, dilution, dispersion, and sorption

General Response Action	Technology	Process Option
In-Situ Treatment	Biological	Aerobic bioremediation with addition of an oxygen releasing compound
		Anaerobic bioremediation with injection of an electron-donor compound
	Chemical	Chemical oxidation

3.2 DETAILED SCREENING OF GROUNDWATER TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 <u>No Action</u>

No Action consists of maintaining the status quo at the site. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

<u>Effectiveness</u>

The No Action alternative would not be effective in meeting the groundwater RAOs. Evaluation of reductions in groundwater COCs through natural attenuation or the potential migration of COCs off site or to another medium could not be achieved because no monitoring would be performed. Human health evaluation through this response action would not be possible.

<u>Implementability</u>

There would be no implementability concerns because no action would be implemented.

<u>Cost</u>

Because hazardous substances, pollutants, or contaminants would be present on site in excess of levels that allow for unlimited use and unrestricted exposure, statutory five-year reviews would be conducted. Costs would be low.

<u>Conclusion</u>

The No Action option will be retained for further consideration, as required by the NCP.

3.2.2 Limited Action

3.2.2.1 Land Use Controls

Land use controls (LUCs) would be designed to protect public health and the environment from residual contamination at environmental sites. LUCs would consist of administrative or legal mechanisms (e.g., deed or zoning restrictions, permits, etc.) designated as institutional controls. Site-specific LUCs would typically be formulated through a LUC Remedial Design (RD) that is prepared in accordance with the Navy's LUCs Principles (DoD, 2003) following approval of the ROD. LUCs would typically also include the performance of regular site inspections to verify continued implementation. Depending upon the site-specific conditions, LUCs can be used alone or in conjunction with other remedial actions.

Effectiveness

Site use restrictions would be effective for minimizing human exposure to site COCs through the use of access controls and/or implementation of deed restrictions. Deed or zoning restrictions could be effectively used to prevent residential use of the Site – permanently if no other remedial measures were undertaken or temporarily while remediation is ongoing. The effectiveness of these measures would be dependent on adequate enforcement of administrative controls. Because the site will be developed and used in the future consistent with the Zoning and Land use By-Laws and the Reuse Plan, physical restrictions such as fencing, physical barriers, and site security would not generally be applicable. Short-term LUCs could be effectively implemented during remedial action until cleanup goals are reached.

Implementability

Current site use is controlled by the Navy. There are no unacceptable risks to current site use scenarios, however, since the Site will be redeveloped in the future, limitations on use (e.g. residential use, well installation) of the Site would be readily implementable as part of the property transfer process and documentation. Short-term LUCs until remedial action is completed would be easily implemented since remedial activities would likely occur prior to property transfer.

Cost

Site use restrictions are generally inexpensive, although long-term administration, enforcement, and maintenance are required if applied long-term.

Conclusion

Institutional controls in the form of passive LUCs are retained in combination with other process options for the development of groundwater remedial alternatives.

3.2.2.2 Monitoring

Sampling and analysis of groundwater would be used to evaluate migration of COCs. Monitoring would also be used to monitor potential natural attenuation or the progress of active groundwater remediation.

Effectiveness

Monitoring would not of itself reduce the toxicity, mobility, or volume of COCs in groundwater, but it would allow the evaluation of potential migration of these COCs and the expected reductions in their concentrations through natural attenuation or active remediation. Monitoring of manganese would be effective as a long term monitoring item.

Implementability

A groundwater monitoring program could be readily implemented and is routinely performed at other sites. Monitoring well installation would need to comply with state and local regulations.

Cost

In general, monitoring costs are low; however, such costs can become high if an extensive monitoring program is implemented over a long period of time.

Conclusion

Monitoring is retained in combination with other process options for the development of groundwater remedial alternatives.

3.2.2.3 Natural Attenuation with Monitoring

Natural attenuation with monitoring would consist of allowing naturally occurring processes such as biodegradation, dispersion, dilution, and adsorption to reduce concentrations of groundwater COCs over time. To evaluate natural attenuation, groundwater samples would be regularly collected and analyzed to establish trends in COC concentrations. Installation of new monitoring wells may be required. Samples from new and existing wells would be regularly collected and analyzed for natural attenuation parameters such as oxidation-reduction potential (ORP), dissolved oxygen (DO), pH, alkalinity, temperature, conductivity, total organic carbon (TOC), ferrous and total iron, sulfur compounds (sulfide and sulfate), nitrogen compounds (nitrite and nitrate), orthophosphate, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide).

Effectiveness

Sufficient groundwater analytical data are not currently available to establish clear trends in the concentrations of COCs at the Site. NNPA is amenable to long-term natural attenuation primarily through aerobic biodegradation. Conversely, TCE, 1,1,1-TCA, and 1,1-DCA are most effectively attenuated through anaerobic biodegradation. Natural attenuation of manganese would be achieved primarily through dispersion, dilution, and abiotic mechanisms. Although attenuation alone would not likely reduce COCs below acceptable human health humans within a reasonable timeframe, natural attenuation for readily attenuated COCs and treatment of less attenuated COCs under a supplemental process option could be an effective approach.

Implementability

Natural attenuation with monitoring would be very easy to implement because it requires monitoring as the only action. As noted earlier, the resources and materials required for monitoring are readily available.

Cost

In general, monitoring costs are low; however, such costs can become high if an extensive natural attenuation monitoring program is implemented over a long period of time.

Conclusion

Natural attenuation with monitoring of COCs is not expected to attain PRGs within a short timeframe but based on the types and concentration of COCs, the process can be applied to the entire site.

3.2.3 In-Situ Treatment

The technologies considered under this GRA include enhanced bioremediation and chemical oxidation.

3.2.3.1 Enhanced Bioremediation

Enhanced bioremediation involves the use of microorganisms, primarily bacteria and fungi, to break down contaminants into nontoxic or less toxic forms. In-situ enhanced bioremediation incorporates biostimulation and/or bioaugmentation. Aerobic and anaerobic biostimulation processes are evaluated below.

Biostimulation is the most common type of in-situ enhanced bioremediation and can be used to stimulate the growth of either anoxic/anaerobic or aerobic indigenous microorganisms depending on the type of contaminant to be biodegraded. Anoxic/anaerobic biostimulation consists of using an electron donor compound such as lactic acid or emulsified oil substrate (EOS), and aerobic biostimulation consists of using either oxygen or an oxygen-release compound (ORC) such as magnesium peroxide.

Injection of EOS within the treatment zones will enhance reductive dechlorination as the primary mechanism for chlorinated VOC biodegradation. The reductive dechlorination process occurs under anaerobic (oxygen-deficient) conditions. The general reduction dechlorination sequence is TCE to DCE isomers and then DCE to VC. Thereafter, VC reduces to ethene and eventually to carbon dioxide, water, and chloride ions via mineralization.

The three primary reductive dechlorination processes resulting from the injection of EOS include direct anaerobic, cometabolic anaerobic, and abiotic reductive dechlorination. Direct anaerobic reductive dechlorination occurs when biological reactions gain energy as chlorine atoms are replaced with hydrogen. Cometabolic anaerobic dechlorination involves enzyme or co-factor reduction of chlorinated VOCs during microbial metabolism of another organic compound. Abiotic reductive dechlorination via direct chemical reduction occurs in the presence of a reducing compound when chlorine atoms are replaced with hydrogen.

Of the site contaminants, TCE is the most susceptible to reductive dechlorination. The potential for VC to accumulate, or for reductive dechlorination processes to “stall” as DCE isomers, may occur when these constituents are generated at a faster rate than they are degraded. However, accumulation or stall may be minimal if bacterial populations of dehalococcoides (DHC) are sufficient to complete the TCE to ethene degradation pathway. DHC has been demonstrated to completely degrade from TCE to ethene.

Bioaugmentation is less common and is typically used in addition to biostimulation. Bioaugmentation consists of using a bacterial culture to increase the naturally occurring microorganism population and to provide organisms specifically targeted to the degradation of COCs. In instances where accumulation or degradation stall of DCE and VC occur during anaerobic bioremediation processes, bioagumentation via injection of DHC may be conducted to complete the degradation pathway.

The enhanced bioremediation reagent (electron donor compound, oxygen, ORC, and/or bacterial culture) can be easily fed into contaminated groundwater using multiple temporary DPT injection points and/or permanent injection wells. Anaerobic and aerobic treatment applications would be location-specific, based on the suitability of a contaminant plume to degrade aerobically or anaerobicaly. DPT injection would be simple to implement and would be applied selectively in small locations or across large surface areas. Enhanced bioremediation can also be used as a barrier technology by positioning one or more lines of injection points (biotreatment barriers) in the projected path of a contaminant plume.

Effectiveness

Enhanced anaerobic bioremediation would be an effective process option primarily for TCE, 1,1,1-TCA, and 1,1-DCA. Enhanced aerobic bioremediation would be an effective option for biodegradation of NNPA. This technology would not be effective in reducing concentrations of manganese in groundwater.

Implementability

Site characteristics are well suited to the application of enhanced bioremediation in shallow and deep groundwater. However, due to the variation of lithology between shallow and deep groundwater overburden, a different injection approach is recommended for the two intervals since the cost of installing DPT injection points becomes prohibitive if subsurface materials are dense/tight. DPT borings advanced within the deep groundwater interval during RI activities encountered dense overburden, occasionally with boulders, often resulting in boring refusal. Overburden in shallow groundwater was observed to be noticeably less dense than overburden in deep groundwater. Reagent injection via DPT injection points in shallow groundwater and permanent injection wells in deep groundwater would be the assumed injection methods. Injection via DPT injection points and injection wells can be easily implemented and can provide accurate reagent delivery into target areas where COCs were identified above human-health risk levels.

Cost

The capital and O&M costs for enhanced in-situ bioremediation would be moderate.

Conclusion

Enhanced in-situ bioremediation via aerobic enhanced remediation and anaerobic bioremediation is retained in the development of groundwater remedial alternatives. A supplemental process option would be required to address manganese.

3.2.3.2 Chemical Oxidation

In-situ chemical oxidation involves the injection of chemical agents into the contaminant plume. These chemical agents promote the generation of highly reactive hydroxyl radicals that react with the COCs and result in the oxidative cleavage of the carbon-to-carbon bond, yielding water, carbon dioxide, oxygen, and dilute hydrochloric acid as by-products.

Traditionally, the chemical agents used for this purpose have included powerful oxidants such as iron-catalyzed hydrogen peroxide (known as Fenton's Reagent), sodium persulfate, potassium permanganate, or ozone. More recently, milder oxidants such as catalytically complexed sodium percarbonate (marketed as Regenesis RegenOx™) have also been successfully used.

Similar to in-situ biological treatment additives, in-situ chemical oxidation reagents are generally injected in the contaminant plumes using either multiple DPT or permanent injection locations.

<u>Effectiveness</u>

In-situ chemical oxidation with strong oxidants such as Fenton's Reagent is a well-established technology that could be effective for the destruction of COCs. Pilot-scale treatability testing would be highly desirable to confirm effectiveness and to determine injection system design criteria.

The effectiveness of in-situ chemical oxidation can also be impacted by heterogeneous subsurface conditions that could result in uneven distribution of the injected chemical agents and incomplete contact of these agents with the groundwater COCs. Due to the stratigraphic variations associated with the site overburden, a pilot study would be required within the deep and shallow groundwater zones to evaluate oxidant distribution and injection conditions.

<u>Implementability</u>

In-situ chemical oxidation with a strong oxidant could be easily implemented at the site provided distribution of the oxidant to cover the extent of TCE, 1,1,1-TCA, 1,1-DCA, and NNPA within deep groundwater is feasible. The number of qualified contractors specializing in the application of this technology is relatively limited. Application of oxidant could be accomplished with a focused array of DPT injection points in shallow groundwater and deep injection wells within deep groundwater.

The chemical reactions that result from the application of strong oxidizing agents typically generate heat and high pressures that can alter subsurface characteristics and even result in hazardous conditions. In addition, the rapid reactions could potentially release gases into potentially occupied buildings could lead to hazardous conditions within the buildings. Since the Building 82 Site will not be occupied during remedial action, indoor air quality issues will not be an issue, provided the hangar remains vacant throughout the remedial process. Air quality monitoring of the remediation area would be required while strong oxidizing agents are utilized.

Cost

Capital and O&M costs for in-situ chemical oxidation with a strong oxidant would be moderate.

Conclusion

Since oxidation is an effective process option for the treatment of TCE, 1,1,1-TCA, 1,1-DCA, and NNPA and site characteristics are fairly well suited to the application of in-situ chemical oxidation via a strong oxidant, chemical oxidation is retained as a process option. Manganese, if present, will be oxidized into a less soluble form.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities would be conducted at the site to address contamination.	Retain. No action is retained as a baseline comparison with other technologies.
Limited Action	Institutional Controls	Active controls: Physical barriers/ security guards	Fencing, markers, and warning signs to restrict site access.	Eliminate. Restricted access would not reduce risk of exposure to groundwater. Physical barriers would affect site reuse.
		Passive controls: Restrictions on groundwater use	Administrative action such as restricting the use of groundwater as a source of drinking water.	Retain. Groundwater is currently not used as a drinking water source. This technology will limit all future uses of groundwater and thus limit human exposure to groundwater.
	Monitoring	Sampling and analysis	Periodic sampling and analysis of groundwater to track the spread of contamination.	Retain. This technology could assess natural attenuation and/or migration of contaminants and evaluate the progress of active remediation.
	Natural Attenuation	Naturally occurring biodegradation, dilution, dispersion, and sorption	Monitoring groundwater to assess the reduction in concentrations of COCs through natural processes. Also, the storm sewers may have carried away contaminated groundwater.	Retain. This technology may decrease concentrations of COCs. Often used as supplement to a more aggressive process GRA.
Containment	Vertical Barrier	Slurry wall	Use of a low-permeability wall to restrict horizontal migration of groundwater or to redirect groundwater flow.	Eliminate. This technology would not restore groundwater quality. Groundwater treatment would still be needed. Not cost effective for low contaminant concentrations.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
Containment (continued)	Vertical Barrier (continued)	Grout curtain	Pressure injection of grout to form a low-permeability perimeter wall to restrict horizontal migration of groundwater. Or as a fixation method with jet mixing or similar technology.	Eliminate. This technology would not restore groundwater quality. Groundwater treatment would still be needed. Not cost effective for low contaminant concentrations.
		Sheet piling	Metal sheet piling driven into the ground to restrict horizontal migration of groundwater or to redirect groundwater flow.	Eliminate. This technology would not restore groundwater quality. Groundwater treatment would still be needed. Not cost effective for low contaminant concentrations.
	Hydraulic Barriers	Extraction wells	Use of extraction wells and/or collection trenches to restrict horizontal migration of groundwater.	Eliminate. This technology would not restore groundwater quality. Groundwater treatment would still be needed. Heterogeneity would affect capture of groundwater. Not cost effective for low contaminant concentrations.
Removal	Groundwater Extraction	Extraction wells	Series of conventional pumping wells used to remove contaminated groundwater.	Eliminate. Not cost effective at sites with low concentrations, low groundwater velocity, and low hydraulic conductivity. Limited discharge options. Long-term operation of treatment system would interfere with the developer’s plans.

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
		Collection trench	A permeable trench used to intercept and collect groundwater.	Eliminate. Several trenches would be required to address each COC plume. A deep trench would be needed to capture the full depth of the TCE plume. Not cost effective at sites with low concentrations, low groundwater velocity, and low hydraulic conductivity. Limited discharge options. Trencheswould interfere with the developer's plans.
In-Situ Treatment	Biological	Aerobic	Enhancement of biodegradation of organics by addition of nutrients and oxidizers.	Retain. Aerobic biodegradation is effective at removing NNPA.
		Anaerobic	Enhancement of biodegradation of organics in an anaerobic (oxygen-deficient) environment by injection of electron-donor compounds.	Retain. Anaerobic reductive dechlorination is effective at removing TCE, 1,1,1-TCA, 1,1-DCA, and their daughter products. A pilot study is typically required.
	Physical/ Chemical	Air sparging/ Soil vapor extraction	Volatilization of organics by supply of air and extraction of organic compounds.	Eliminate. The heterogeneous subsurface would make effective implementation of this method difficult. Extensive piping would affect future redevelopment.
		Chemical oxidation	Inject oxidizers, such as ozone, hydrogen peroxide, potassium permanganate or sodium persulfate, to chemically treat the COCs.	Retain. This technology could remove the COCs and their daughter products. A pilot study is typically needed.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
		Chemical reduction	Inject reducing chemicals, such as zero-valent iron, to chemically reduce chlorinated VOCs.	Eliminate. This technology would be effective for treating chlorinated VOCs, however, ZVI costs more compared to other reagents. Distribution of the ZVI particles is more difficult than soluble reagents.
		Permeable Reactive barrier	Chemical treatment using barrier wall of reactive agent, such as zero-valent iron, downgradient of source zone.	Eliminate. Large volumes of groundwater and separate COC plume locations would be costly to treat with this process. Low concentrations of COCs are more readily removed by other processes.
Ex-Situ Treatment	Physical	Filtration	Separation of suspended solids from water via entrapment in a bed of granular media or membrane.	Eliminate. Not applicable since groundwater extraction was eliminated.
		Air stripping	Contact of water with air to remove volatile organics.	Eliminate. Not applicable with sites with low groundwater concentrations.
		Liquid-phase granular activated carbon	Separation of volatile contaminants from a liquid stream via adsorption onto activated carbon.	Eliminate. Not applicable since groundwater extraction was eliminated.
		Gas-phase granular activated carbon	Separation of volatilized contaminants from a gas stream via adsorption onto activated carbon.	Eliminate. Not applicable, air stripping is not being considered.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
		Solvent extraction	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the COCs.	Eliminate. Not applicable to low levels of contaminants.
		Oil/Water separation	Separation of oils from water via gravity settling.	Eliminate. Not applicable since contaminants are not present in free-phase.
	Chemical	Ion exchange	Process in which ions, held by electrostatic forces to charged functional groups on a resin surface, are exchanged for ions of similar charge in a water stream.	Eliminate. Not applicable to site contaminants; groundwater extraction eliminated.
Ex-Situ Treatment (continued)	Chemical (continued)	Electrolytic recovery	Passage of an electric current through a solution with resultant ion recovery on positive and negative electrodes.	Eliminate. Not applicable to site contaminants; groundwater extraction eliminated.
		Chemical precipitation	Use of reagents to convert soluble constituents into insoluble constituents.	Eliminate. Not applicable to site contaminants; groundwater extraction eliminated.
		Enhanced oxidation	Use of oxidizers such as ozone, hydrogen peroxide, or potassium permanganate to break down certain organic compounds.	Eliminate. Not applicable to site contaminants; groundwater extraction eliminated.
		Neutralization/ pH adjustment	Use of acids or bases to counteract excess pH.	Eliminate. Not applicable to site conditions.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Option	Description	Screening Comment
Discharge/ Disposal	Surface discharge	Direct discharge (NPDES)	Discharge of treated water to surface water.	Eliminate. Not applicable to site conditions.
		Indirect discharge (IWTP/STP)	Discharge of collected/treated water to a sewage treatment plant (STP).	Eliminate. Weymouth municipal STP is under consent order and may not accept additional flows.
		Offsite treatment Facility	Treatment and disposal of water at an offsite treatment works.	Eliminate. Not applicable to site conditions.
	Subsurface discharge	Reinjection	Use of injection wells, spray irrigation, or infiltration to discharge collected/treated groundwater underground.	Eliminate. Reinjection gallery would interfere with future use and development.

IWTP - Industrial water treatment plant
STP - Sewage treatment plant.
TCE - Trichloroethene.
VOC - Volatile organic compound.
COC - Chemical of concern.
NNPA - n-nitroso-di-n-propylamine.
DCA - Dichloroethane.
NPDES - National Pollutant Discharge Elimination System.

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section presents an evaluation of each remedial alternative with respect to the criteria of the NCP (40 CFR Part 300). These criteria and their relative importance are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance with the NCP (40 CFR Part 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances or contaminants present at the site by eliminating, reducing, or controlling exposure to levels exceeding PRGs. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. CERCLA Section 121(d), specifies in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or a waiver must be obtained [see also 40 CFR 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. In addition, per 40 CFR 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (TBC guidance category).

4.1.1.3 Long-Term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative would prove successful. Factors to be considered, as appropriate, include the following:

- Magnitude of Residual Risk **-** Risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and Reliability of Controls **-** Controls such as containment systems and LUCs that are necessary to manage treatment residuals and untreated waste must be shown to be reliable. For example, the uncertainties associated with land disposal for providing long-term protection from residuals; assessment of the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and potential exposure pathways and risks posed if the remedial action needs replacement must be considered.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume is to be assessed, including how treatment is used to address the principal threats posed by the site. Factors to be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that these processes will treat.

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- The degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the percentage or order of magnitude of the reduction.

- The degree to which the treatment is irreversible.

- The type and quantity of residuals that will remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternative are to be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during the remedial action and the effectiveness and reliability of protective measures.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

Although not a CERCLA-criterion, the sustainability of each alternative was evaluated per Navy policy (Guidance for Optimizing Remedy Evaluation, Selection, and Design, UG-2087-ENV, 2010). Sustainability factors are similar to those evaluated as part of the Short-Term Effectiveness criterion, so they are discussed in this section. Sustainability evaluations provide insight into elements of a remedy that have the greatest impact on the environmental footprint. For example, the amount of greenhouse gas (GHG) emissions related to materials production generally exceeds that from installation, transportation, or operations. Other factors that are considered include emissions of criteria air pollutants, water usage, energy consumption, and worker risk. Sensitivity analysis of such factors can help provide an optimal design that minimizes the overall environmental footprint of the remedial action. Sustainability evaluations were performed for each remedial alternative and are provided in Appendix E.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives is to be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment capacity, storage capacity, and disposal capacity and services; availability of necessary equipment and specialists and provisions to ensure necessary additional resources; availability of services and materials; and availability of prospective technologies.

4.1.1.7 Cost

Capital costs, including both direct and indirect costs, and annual O&M costs are provided. A net present value of the capital and O&M costs is also provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.1.8 State Acceptance

The state's concerns that must be assessed include the following:

- The state's position and key concerns related to the preferred alternative and other alternatives
- State comments on ARARs or the proposed use of waivers

These concerns cannot be evaluated until the state has reviewed and commented on this FS. These concerns will be discussed, to the extent possible, in the Proposed Plan to be issued for public comment.

4.1.1.9 Community Acceptance

This assessment consists of responses of the community to the Proposed Plan and includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment can be conducted after comments on the Proposed Plan are received from the public.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of the alternatives.

The remaining two of the nine criteria: State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. These last two criteria can be evaluated after the FS has been reviewed by the Commonwealth of Massachusetts and the Proposed Plan has been discussed at a public meeting. Therefore, this document addresses only seven of the nine criteria.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a Proposed Plan to the community for review and comment. CERCLA 121(b) stipulates that the preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and the environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of the public comments and determination of whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with the Commonwealth of Massachusetts.

4.2 ASSEMBLY AND DETAILED ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

Based on the detailed screening of technologies and process options presented in Section 3.2, the following five groundwater remedial alternatives were developed based on findings from historic site investigations, the RI (TtNUS, 2010), and the RI Addendum (TtNUS, 2011):

- Alternative G-1: No Action
- Alternative G-2: Chemical Oxidation, LUCs, and Monitored Natural Attenuation
- Alternative G-2A: Chemical Oxidation, LUCs, and Monitoring
- Alternative G-3: In-Situ Enhanced Bioremediation, LUCs, and Monitored Natural Attenuation
- Alternative G-4: LUCs and Monitored Natural Attenuation

Alternative G-1 was analyzed to serve as a baseline for comparison to other alternatives, as required by CERCLA and the NCP. Alternative G-2 was developed as an aggressive alternative to treat groundwater over a short period of time followed by a longer period of time to allow COCs to attenuate. Alternative G-2A was developed as the most aggressive alternative to meet PRGs in a short time frame. Alternative G-3 was developed as a less aggressive alternative over a longer period of time. Alternative G-4 was developed to allow the COCs to attenuate over a long period of time and provide LUCs until cleanup goals are attained. A description and detailed analysis of these alternatives are presented in the following sections.

4.2.1 Alternative G-1: No Action

4.2.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address the groundwater contamination and is retained to provide a baseline for comparison to other alternatives. There would be no reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, biodegradation, and other attenuating factors.

Hazardous substances, pollutants, or contaminants will be present on site in excess of levels that allow for unlimited use and unrestricted exposure, so in accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted every 5 years. The five-year review will consist of a review of relevant documents, interviews, a site inspection, and preparation of a summary report. Because there would be no site monitoring that would indicate whether COC concentrations have reached acceptable levels, five-year reviews are assumed to continue indefinitely.

4.2.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-1 would not be protective of human health because the identified risks at the Site would not be addressed. Because no monitoring would be performed, potential migration of COCs would not be detected. Because there would be no groundwater monitoring, potential off-site migration of COCs would not be detected.

Compliance with ARARs and TBCs

Alternative G-1 would not comply with chemical-specific ARARs or TBCs because no action would be taken to reduce contaminant concentrations. Chemical-specific ARARs may be eventually met by natural attenuation, but there would be no monitoring to verify the changes. Compliance with location-specific ARARs or TBCs would be purely incidental. Action-specific ARARs or TBCs are not applicable. The chemical-specific ARARs and TBCs for Alternative G-1 are listed in Table 4-1.

Long-Term Effectiveness and Permanence

Alternative G-1 would have little long-term effectiveness and permanence because: contaminated groundwater would remain on site; there would be no LUCs to restrict construction methods; and there would be no groundwater monitoring so potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease to PRGs through natural attenuation, there would be no monitoring to confirm this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-1 would not reduce toxicity, mobility, or volume of groundwater COCs through treatment because no treatment would occur. Some reduction of the toxicity and volume of COCs might occur through natural dispersion, dilution, or other attenuation processes, but no monitoring would be performed to confirm this. Although natural attenuation processes would occur over time, this is not likely to occur within a reasonable timeframe.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative G-1 would not have any short-term adverse impact from cleanup activities to the local community or the environment. Alternative G-1 might achieve the RAOs. Although the PRGs might eventually be achieved through natural attenuation, this would not be confirmed through monitoring. There are no sustainability impacts to consider because no actions would be implemented.

Implementability

Because no action would occur, Alternative G-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of additional administrative measures is not applicable because no such measures would be taken.

Cost

The only costs are for Five-Year Reviews. The estimated costs for Alternative G-1 are as follows:

Capital Cost:	$ 8,000
Net present worth (NPW) of O&M Costs:	$109,000
NPW:	$117,000

NPW is based on 30 years. A detailed breakdown of estimated costs for this alternative is provided in Appendix F.

4.2.2 Alternative G-2: Chemical Oxidation, LUCs, and Monitored Natural Attenuation

4.2.2.1 Description

Alternative G-2 would consist of three major components: (1) chemical oxidation, (2) LUCs, and (3) monitored natural attenuation.

Component 1: Chemical Oxidation

This component would consist of injection of Fenton's reagent, a strong chemical oxidant. Oxidant injection would consist of DPT borings within shallow groundwater and injection wells within deep groundwater for chemical oxidation of the COCs.

The injection system would consist of a grid of DPT points in the shallow groundwater zone and a grid of injection wells in the deep groundwater zone. Because of the low COC concentrations, it is assumed that one injection event would be required to achieve chemical oxidation of the COCs. The proposed arrangements of the injection points are illustrated on Figure 4-1. In the deep TCE plume, the area within the 10 µg/L concentration contour would be treated. The estimated number of injection points and wells, the quantity of 12.5-percent (by weight) solution of Fenton's reagent injected, and dilution water requirements are summarized below. A pilot study would be performed to confirm well spacing and Fenton's reagent application rates.

Plume (Depth Interval, Feet bgs)	Locations	Points per location	No. of injection points	12.5% peroxide (gal)	Dilution Water (gal)
Shallow TCE Plume (5 to 25)	7	2	14	19,600	15,000
Deep TCE Plume (25 to 45)	60	2	120	187,800	148,000
Shallow 1,1,1-TCA and 1,1-DCA (10 to 20)	7	1	7	1,500	1,000
Shallow NNPA (10 to 20)	7	1	7	1,500	1,000

Water level measurements obtained during the RI indicate that shallow groundwater within the vicinity of the treatment area discharges to the two 42-inch stormwater sewers located west of Hangar 2. Although Fenton's reagent is a short-lived reagent and is not expected to flow beyond the injection area, the area around the two 42-inch stormwater sewers and adjacent monitoring wells will be monitored to determine if any discharge of oxidants into the stormwater sewer occurs. Appropriate adjustments to injection rates and dosages could be made to control injections to minimize downstream flow.

Prior to the remedial design, groundwater samples would be collected from existing monitoring wells that have COC concentrations greater than the PRGs, and possibly wells downgradient of these wells, to determine the presence of contamination. Monitoring of groundwater would be required to assess the performance of chemical oxidation. Performance monitoring would include collecting groundwater samples from monitoring wells located within the contaminant plumes to assess trends in concentrations of COCs and on the periphery of the plumes to evaluate potential migration of COCs. Generally samples would be analyzed for field parameters (pH, DO, ORP, specific conductivity, turbidity, and groundwater elevation), COCs (TCE, 1,1,1-TCA, 1,1-DCA, and NNPA), and COC daughter products.

Approximately 2 years would be required for treatment. The need for and locations of additional injection events will be determined based on the performance monitoring. Although in-situ chemical oxidation (ISCO) may impact the existing bacterial community, since the injections are vertically focused the bacterial populations are expected to recover within 5 to 10 years due to dispersion and advection of groundwater. The bacterial community downgradient of the planned injections will be unaffected by the

ISCO. Five-year reviews would be performed as long as contaminants are present at concentrations that prevent unrestricted site use.

Conceptual design calculations are provided in Appendix D.

Note that several injection points are within the footprint of Building 41. Asbestos-containing material is present inside the building and must be addressed prior to demolition of the structure. The need for, timing, and costs of the demolition and asbestos remediation and its effects on groundwater remediation, if any, will be determined during the Remedial Design.

Component 2: LUCs

LUCs would be implemented on an interim basis to prevent unacceptable risks from exposure to contaminants in groundwater until the PRGs are achieved. The LUCs would: (1) prohibit the installation of groundwater production, supply, or irrigation wells at the Building 82 Site; and (2) require that USEPA and MassDEP approval of construction dewatering plans to be obtained prior to conducting construction dewatering activities at the Building 82 Site. The LUCs will be narrowly tailored to the prevention of specific, identified risks and exposure scenarios identified in the HHRA and will be limited in scope, duration and location so as not to unreasonably burden or prohibit foreseeable uses anticipated by the Reuse Plan.

Annual inspections of the site would be conducted to confirm compliance with the LUC objectives, and annual compliance certificates would be prepared and provided to USEPA and MassDEP. Prior to any property conveyance, USEPA and MassDEP would be notified.

The LUCs would be maintained for as long as they are required to prevent unacceptable exposure to contaminated groundwater for production, supply, or irrigation use and/or to preserve the integrity of the selected remedy. The LUCs, in accordance with Navy LUC Principles (DoD, 2003), would be implemented through a LUC Remedial Design (RD) that would be prepared as a component of the overall RD.

Component 3: Monitored Natural Attenuation

Natural attenuation would rely on naturally occurring processes within the aquifer to reduce the concentrations of COCs and restore the aquifer to its beneficial use. Monitored natural attenuation activities would be conducted according to the requirements of OSWER Directive 9200.4-17P. Manganese concentrations would be primarily reduced through dispersion, dilution through aquifer movement, and by precipitation of manganese into groundwater zones with oxidizing conditions.

Note that the evidence for biological natural attenuation is weak. Other than the VOC data, there are currently few other natural attenuation indicator data. Of the groundwater sample locations in the area (MW-10S, MW-10D, E03, H01, H02, H03, and H04), all but MW-10S have highly negative ORP values, which are favorable for anaerobic dechlorination. Half of the DO concentrations are less than 1 mg/L, which is also favorable for anaerobic dechlorination. The absence of cis-1,2-DCE, and vinyl chloride may be due to a very slow degradation rate due to the very low TCE concentrations. The absence of cis-1,2-DCE and vinyl chloride may also be the results of complete degradation of TCE. Note that biological degradation is just part of the overall natural attenuation process. Natural attenuation also includes physical processes, such as dispersion, dilution, and sorption. Because of the low groundwater velocity, the contaminants will migrate slowly. Sorption to naturally occurring organic material will limit the migration and supplement the attenuation. Additional natural attenuation indicator parameter data will be collected as part of the Remedial Design.

Natural attenuation monitoring would consist of collecting groundwater samples from monitoring wells for manganese and TCE from locations in the deep and shallow TCE plumes. TCE and daughter products of TCE would be monitored within existing monitoring wells to the extent possible. If necessary, additional monitoring wells would be installed. In addition, natural attenuation parameters would be monitored [ORP, DO, pH, alkalinity, temperature, conductivity, TOC, ferrous and total iron, sulfur compounds (sulfide and sulfate), nitrogen compounds (nitrite and nitrate), orthophosphate, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide)]. Sampling frequency would be quarterly for the first year, semi-annual for the next 2 years, and annual thereafter. Thirteen wells are assumed to be needed for MNA monitoring. While the costing estimates in Appendix F are based on the information above, details such as the number and location of monitoring wells, analytes and monitoring frequency, will be determined during development of the long-term monitoring plan as part of the remedial design. Prior to the remedial design and preparation of the long-term monitoring plan, a baseline sampling event would be conducted. Groundwater samples would be collected from monitoring wells that have COC concentrations greater than PRGs to determine the presence of contamination and establish baseline conditions.

The baseline sampling event will include collection of samples for natural attenuation parameters. These data will be used to supplement the limited evidence of reductive degradation discussed in the RI. Should the baseline and subsequent monitoring data indicate little biodegradation of TCE, contingency actions may be required to enhance or stimulate the native microbial population. The baseline sampling event would also include collection of samples from selected monitoring wells for PCB and MTBE analysis. If PCBs are detected, further investigation or remedial action for PCBs in groundwater would be considered.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and Environment

Alternative G-2 would be protective of human health and the environment. By actively removing the sources of contamination, in-situ chemical oxidation would significantly reduce the risk from exposure to contaminated groundwater and provide protection to future human receptors that may use this aquifer as a groundwater production, supply or irrigation source.

LUCs would be protective of human health and the environment during the remedial period until PRGs are met. Once the PRGs have been achieved, the human health risk will be calculated using the groundwater monitoring data to determine whether the concentrations result in excess human health risk. Restricting the use of aquifer groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater.

Monitoring would be protective by evaluating the effectiveness of the in-situ treatment, detecting potential migration of groundwater COCs, and monitoring levels of MTBE and manganese. Monitoring of PCBs at the indicated locations would provide protection to human health and the environment by further evaluating the presence of this parameter. If PCBs are detected in future sampling rounds additional investigation and/or groundwater treatment would be considered.

Although COCs have not been detected in surface water at concentrations above water quality criteria, there is a possibility that contamination could migrate at low concentrations into the 42-inch stormwater drainage system or surface water. Contingency action(s) may be implemented if COCs are detected in stormwater or surface water at concentrations above water quality criteria. Examples of possible actions include: hydraulic barriers; in-situ treatment (such as oxidation); and other processes (e.g., air sparging, pure oxygen injection, or oxygen-releasing compound) to introduce oxygen to the groundwater to decrease the solubility of iron and manganese.

No adverse short-term or cross media effects are anticipated as a result of implementing this alternative. However there may be impacts on the bacterial community in the immediate area of the ISCO injections.

By restricting groundwater use via LUCs until PRGs are attained, Alternative G-2 would also achieve RAO No. 1. Alternative G-2 would achieve RAO Nos. 2 and 3 once COCs have been completely treated.

Compliance with ARARs and TBCs

Alternative G-2 would eventually comply with chemical-specific ARARs and TBCs through a combination of chemical oxidation and natural attenuation. Alternative G-2 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-2 are listed in Tables 4-2, 4-3, and 4-4, respectively.

Long-Term Effectiveness and Permanence

Alternative G-2 would provide long-term effectiveness and permanence.

In-situ chemical oxidation would effectively remove COC contamination present on-site. In-situ chemical oxidation is a relatively well-established technology, but its site-specific effectiveness for treatment would have to be verified through pilot-scale treatability testing.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met.

Monitoring would be an effective means to evaluate the progress of remediation, monitor the absence or presence of PCBs, monitor levels of MTBE and manganese, and to confirm that no migration of COCs is occurring. Daughter products of TCE degradation that also have a high toxicity, such as vinyl chloride, may persist and will also be monitored.

The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-2 would reduce the toxicity, mobility, and volume of the contaminated groundwater. In-situ chemical oxidation would permanently and irreversibly remove an estimated 0.35 pound of COCs (0.317 pound of TCE, 0.03 pound of 1,1,1-TCA, 0.005 pound of 1,1-DCA, and 2.0×10^{-5} pound of NNPA). Treatment residuals would not be generated by the complete chemical oxidation of the COCs.

Short-Term Effectiveness

Alternative G-2 would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during installation of injection wells, construction and operation of the injection system, and groundwater sampling would be minimized by compliance with the requirements of the Occupational Safety and Health Act (OSHA), including wearing of appropriate personal protective equipment (PPE) and adherence to site-specific health and safety procedures. Implementation of LUCs would not adversely impact the surrounding community or the environment.

The environmental footprint of each of the impact categories evaluated using SiteWise™ is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. Overall, Alternative G-2 has a moderate to high impact on sustainability. Emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Alternative G-2 contained moderate CO_2e emissions (4,700 tons), largely due to emissions from Fenton's Reagent material production. Criteria pollutant emissions associated with Alternative G-2 for nitrous oxides (NO_x), sulfur oxides (SO_x), and particulate matter (PM_{10}) emissions were 0.16, 7.7, and 2.9 tons, respectively. For NO_X, the highest contributor to these emissions was the laboratory analytical services; for SO_X and PM_{10}, the highest contributor to these emissions was the production of the Fenton's Reagent. Energy demand for Alternative G-2 was moderate [124,000 million British Thermal Units (MMBTUs)] and was largely attributed to the energy demand associated with Fenton's reagent material manufacture. Water usage associated with Fenton's reagent dilution resulted in a moderate water usage impact.

Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs provided the LUCs are implemented until RAO Nos. 2 and 3 are achieved. Based on operating experience with similar systems, it is anticipated that Alternative G-2 would remove the COCs within the treatment zone within approximately 2 years and achieve RAO No. 2 for the VOCs. Natural attenuation of the balance of the plume would take approximately 20 to 25 years to achieve RAO No. 3 and permanently achieve RAO No. 1 for the VOCs. Time frame estimates are based on the Biochlor model results in Appendix D. The time for manganese concentrations to reach its PRG is uncertain, so monitoring for manganese is assumed to be required for the entire 30-year cost evaluation period.

Implementability

Alternative G-2 would be readily implementable.

The chemical oxidation approach of oxidant injection via shallow DPT points and deep injection wells could be readily installed and operated for the in-situ chemical oxidation of COCs. The number of qualified contractors would be somewhat limited but not overly restrictive. Sampling and maintenance of existing monitoring wells and performance of 5-year reviews during the remedial action and monitored natural attenuation phases could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The effectiveness and design of in-situ chemical oxidation would have to be confirmed through pilot-scale treatability testing. The design will also take into account the locations of existing subsurface utilities and storm sewer lines.

The administrative aspects of Alternative G-2 would be relatively simple to implement. If a change in ownership of the site occurs, appropriate provisions would be incorporated into the property transfer documents to ensure continued implementation of aquifer use restrictions and monitoring. Injections and operations associated with oxidant injection would only have to comply with the substantive requirements of any identified ARARs.

Implementation of Alternative G-2 would have a short-term impact on development of approximately 2 years during injection of chemical oxidant. Implementation of monitoring would result in a long-term development impact until PRGs are met.

<u>Cost</u>

The estimated costs for Alternative G-2 are as follows:

Capital Cost:	$1,615,000
NPW of O&M Costs:	$1,111,000
NPW:	$2,727,000

NPW is based on 30 years. A detailed breakdown of estimated costs for this alternative is provided in Appendix F.

4.2.3 <u>Alternative G-2A: Chemical Oxidation, LUCs, and Monitoring</u>

4.2.3.1 Description

Alternative G-2A would consist of three major components: (1) chemical oxidation, (2) LUCs, and (3) monitoring.

<u>Component 1: Chemical Oxidation</u>

This component would consist of injection of an oxidizer. For this FS, the injection of Fenton's reagent, a strong chemical oxidant, is assumed. Oxidant injection would consist of DPT borings within shallow groundwater and injection wells within deep groundwater for chemical oxidation of the COCs.

The injection system would consist of a grid of DPT points in the shallow groundwater zone and a grid of injection wells in the deep groundwater zone. Because of the low COC concentrations, it is assumed that one injection event would be required to achieve chemical oxidation of the COCs. The proposed arrangements of the injection points are illustrated on Figure 4-2. In the deep TCE plume, the area within the 5 µg/L concentration contour would be treated. The estimated number of injection points and wells, the quantity of 12.5-percent (by weight) solution of Fenton's reagent injected, and dilution water requirements are summarized below. The injections would be in phases. The first phase would be in the higher concentrations in the center of the plume. Information from the first phase would be used to optimize the well spacing and injection rates and quantities on the second phase.

Plume (Depth Interval, Feet bgs)	Locations	Points per location	No. of injection points	12.5% peroxide (gal)	Dilution Water (gal)
Shallow TCE Plume (5 to 25)	7	2	14	19,600	15,000
Deep TCE Plume (25 to 45)	104	2	208	361,000	285,000
Shallow 1,1,1-TCA and 1,1-DCA (10 to 20)	7	1	7	1,500	1,000
Shallow NNPA (10 to 20)	7	1	7	1,500	1,000

Water level measurements obtained during the RI indicate that shallow groundwater within the vicinity of the treatment area discharges to the two 42-inch storm water sewers located west of Hangar 2. Although Fenton's reagent is a short-lived reagent and is not expected to flow beyond the injection area, the area around the two 42-inch storm water sewers and adjacent monitoring wells will be monitored to determine if any discharge of oxidants into the storm water sewer occurs. Appropriate adjustments to injection rates and dosages could be made to control injections to minimize downstream flow.

Prior to the remedial design, groundwater samples would be collected from existing monitoring wells that have COC concentrations greater than the PRGs, and possibly wells downgradient of these wells, to determine the presence of contamination. Monitoring of groundwater would be required to assess the performance of chemical oxidation. Performance monitoring would include collecting groundwater samples from monitoring wells located within the contaminant plumes to assess trends in concentrations of COCs and on the periphery of the plumes to evaluate potential migration of COCs. Generally samples would be analyzed for field parameters (pH, DO, ORP, specific conductivity, turbidity, and groundwater elevation), COCs (TCE, 1,1,1-TCA, 1,1-DCA, and NNPA) and COC daughter products.

Approximately 2 years would be required for treatment. Performance monitoring would be performed for 3 years at semiannual intervals to confirm that the concentrations are less than PRGs and that no rebound has occurred. Five-year reviews would be performed as long as contaminants are present at concentrations that prevent unrestricted site use.

Conceptual design calculations are provided in Appendix D.

Note that several injection points are within the footprint of Building 41. Asbestos-containing material is present inside the building and must be addressed prior to demolition of the structure. The need for, timing, and costs of the demolition and asbestos remediation and its effects on groundwater remediation, if any, will be determined during the Remedial Design.

Component 2: LUCs

This component would be identical to Component 2 of Alternative G-2.

Component 3: Monitoring

Performance monitoring will be used to evaluate the progress of remediation. It is anticipated that 3 years of performance monitoring will be required. Other analytes of interest, such as manganese, PCBs, and MTBE, will also be monitored. Naturally occurring processes within the aquifer would reduce the concentrations of manganese. Manganese concentrations would be primarily reduced through dispersion, dilution through aquifer movement, and by precipitation of manganese into groundwater zones with oxidizing conditions. Groundwater samples from selected wells would also be analyzed for PCBs and MTBE.

A baseline sampling event would include collection of samples from selected monitoring wells for PCB and MTBE analysis. If PCBs are detected, further investigation or remedial action for PCBs in groundwater would be considered.

4.2.3.2 Detailed Analysis

Overall Protection of Human Health and Environment

Alternative G-2A would be protective of human health and the environment. By actively removing the contamination greater than PRGs, in-situ chemical oxidation would significantly reduce the risk from exposure to contaminated groundwater and provide protection to future human receptors that may use this aquifer as a groundwater production, supply, or irrigation source.

LUCs would be protective of human health and the environment during the remedial period until PRGs are met. Once the PRGs have been achieved, the human health risk will be calculated using the groundwater monitoring data to determine whether the concentrations result in excess human health risk.

Restricting the use of aquifer groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater.

Monitoring would be protective by evaluating the effectiveness of the in-situ treatment and monitoring levels of MTBE and manganese. Monitoring of PCBs at the indicated locations would provide protection to human health and the environment by further evaluating the presence of this parameter. If PCBs are detected in future sampling rounds additional investigation and/or groundwater treatment would be considered.

Although COCs have not been detected in surface water at concentrations above water quality criteria, there is a possibility that contamination could migrate at low concentrations into the 42-inch storm water drainage system or surface water. Contingency action(s) may be implemented if COCs are detected in storm water or surface water at concentrations above water quality criteria. Examples of possible actions include: hydraulic barriers; in-situ treatment (such as oxidation); and other processes (e.g., air sparging, pure oxygen injection, or oxygen-releasing compound) to introduce oxygen to the groundwater to decrease the solubility of iron and manganese.

No adverse short-term or cross media effects are anticipated as a result of implementing this alternative.

By restricting groundwater use via LUCs until PRGs are attained, Alternative G-2A would also achieve RAO No. 1. Alternative G-2A would achieve RAO Nos. 2 and 3 once COCs have been completely treated.

Compliance with ARARs and TBCs

Alternative G-2A would eventually comply with chemical-specific ARARs and TBCs by chemical oxidation. Alternative G-2A would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-2A are listed in Tables 4-5, 4-6, and 4-7, respectively.

Long-Term Effectiveness and Permanence

Alternative G-2A would provide long-term effectiveness and permanence.

ISCO would effectively remove COC contamination present on-site. In-situ chemical oxidation is a relatively well-established technology, but its site-specific effectiveness for treatment would have to be verified through treatment in phases.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met.

Monitoring would be an effective means to evaluate the progress of remediation, monitor the absence or presence of PCBs, and monitor levels of MTBE and manganese. Daughter products of TCE degradation that also have a high toxicity, such as vinyl chloride, may persist and will also be monitored.

The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-2A would reduce the toxicity, mobility, and volume of the contaminated groundwater. In-situ chemical oxidation would permanently and irreversibly remove an estimated 0.35 pound of COCs (0.317 pound of TCE, 0.03 pound of 1,1,1-TCA, 0.005 pound of 1,1-DCA, and 2.0×10^{-5} pound of NNPA). Treatment residuals would not be generated by the complete chemical oxidation of the COCs.

Short-Term Effectiveness

Alternative G-2A would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during installation of injection wells, construction and operation of the injection system, and groundwater sampling would be minimized by compliance with the requirements of the OSHA, including wearing of appropriate personal protective equipment (PPE) and adherence to site-specific health and safety procedures. Implementation of LUCs would not adversely impact the surrounding community or the environment.

The environmental footprint of each of the impact categories evaluated using SiteWise™ is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. Overall, Alternative G-2A has a high impact on sustainability. Emissions of CO_2, CH_4, and N_2O were normalized to CO_2e. Alternative G-2A contained high CO_2e emissions (8,600 tons), largely due to emissions from Fenton's Reagent material production. Criteria pollutant emissions associated with Alternative G-2A for NO_x, SO_x, and PM_{10} emissions were 0.22, 14, and 5.3 tons, respectively. For NO_X, the highest contributor to these emissions was the laboratory analytical services; for SO_X and PM_{10}, the highest contributor to these emissions was the production of the Fenton's Reagent. Energy demand for Alternative G-2A was high (225,000 MMBTUs) and was largely attributed to the energy demand associated with Fenton's reagent material manufacture. Water usage associated with Fenton's reagent dilution resulted in a high water usage impact.

Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs, provided the LUCs are implemented until RAO Nos. 2 and 3 are achieved. Based on operating experience with similar systems, it is anticipated that Alternative G-2A would remove the COCs within the treatment zone within approximately 2 years and achieve RAO Nos. 2 and 3 for the VOCs. The time for manganese concentrations to reach its PRG is uncertain, so monitoring for manganese is assumed to be required for the entire 30-year cost evaluation period.

<u>Implementability</u>

Alternative G-2A would be readily implementable.

The chemical oxidation approach of oxidant injection via shallow DPT points and deep injection wells could be readily installed and operated for the in-situ chemical oxidation of COCs. The number of qualified contractors would be somewhat limited but not overly restrictive. Sampling and maintenance of existing monitoring wells and performance of 5-year reviews during the remedial action and performance monitoring could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The effectiveness and design of in-situ chemical oxidation would have to be confirmed through a phased approach. The design will also take into account the locations of existing subsurface utilities and storm sewer lines.

The administrative aspects of Alternative G-2A would be relatively simple to implement. If a change in ownership of the site occurs, appropriate provisions would be incorporated into the property transfer documents to ensure continued implementation of aquifer use restrictions and monitoring. Injections and operations associated with oxidant injection would only have to comply with the substantive requirements of any identified ARARs.

Implementation of Alternative G-2A would have a short-term impact on development for approximately two years during injection of chemical oxidant and then for three years during performance monitoring. Implementation of monitoring would result in a long-term development impact until PRGs are met.

<u>Cost</u>

The estimated costs for Alternative G-2A are as follows:

Capital Cost:	$2,397,000
NPW of O&M Costs:	$ 875,000
NPW:	$3,272,000

NPW is based on 30 years. A detailed breakdown of estimated costs for this alternative is provided in Appendix F.

4.2.4 Alternative G-3: In-Situ Enhanced Bioremediation, LUCs, Monitored Natural Attenuation

4.2.4.1 Description

Alternative G-3 would consist of three major components: (1) in-situ enhanced bioremediation, (2) LUCs, and (3) monitored natural attenuation.

<u>Component 1: In-Situ Enhanced Bioremediation</u>

For anaerobic biodegradation of TCE, EOS would be injected into the subsurface along lines (barriers) perpendicular to the groundwater flow direction and/or apparent plume orientation (see Figure 4-3). The shallow TCE plume may be treated with a single barrier at the downgradient edge of the plume because of the relatively fast groundwater velocity in the shallow overburden compared to the deep overburden. The deep TCE plume would require multiple barriers along the length of the plume due to the relatively slow groundwater velocity. The VOCs 1,1-DCA and 1,1,1-TCA at GP-A01 will be treated by locally-spaced EOS injection points.

For the shallow TCE plume, 7 shallow DPT injection points will be spaced on 10-foot centers along a barrier line based on the anticipated injection radius of influence. In consideration of the TCE transport calculations (Appendix D), one barrier would be required, which is based on the groundwater travel time of 5 years, the typical length of time that EOS remains effective.

EOS would be injected into the deep zone within the 10 µg/l contour via 44 injection locations distributed along 7 barriers. Each injection location will consist of an injection well cluster containing wells at two depths, with approximate screen intervals of 20 to 30 feet bgs and 30 to 40 feet bgs. Considering the calculated TCE velocity of 2.6 feet per year, the spacing between the barrier lines will be 50 feet, based on an overall travel time of 20 years. Accordingly, the spacing between individual wells in the deep zone would be 10-feet along the barrier lines to account for EOS distribution requirements. Accounting for the

5-year lifespan of EOS, substrate injection events will occur every 5 years (Years 5, 10, and 15) within the deep TCE plume injection wells.

For the shallow 1,1,1-TCA and 1,1-DCA plume, 7 shallow DPT injection points will be placed in a hexagonal orientation to establish a treatment zone proximal to GP-A01. The spacing is based on 15-foot injection point spacing and 1,1,1-TCA and 1,1-DCA transport calculations (Appendix D).

The estimated number of injection points and wells and the quantity of EOS concentrate and dilution water injected is summarized below. A buffered EOS product (EOS AquaBupH) may be required because of the relatively low pH and low alkalinity of site groundwater and soil. A pilot study would be performed to confirm well spacing and EOS application rate. Pre-pilot study sampling for overburden oil absorption characteristics (for EOS absorption analysis) and groundwater and soil acidity within the treatment zones will be required prior to pilot testing and will be used for pilot study design and substrate selection.

Plume Location (Depth Interval, feet bgs)	Number of Barriers	Number of Injection Points	Total EOS Added, gallons	Total Water Added, gallons
Shallow TCE Plume (5 to 25)	1	7	330	3,000
Deep TCE Plume (25 to 45)	7	88	4,500	40,600
Shallow 1,1,1-TCA and 1,1-DCA Plume (10 to 20)	NA	7	110	1,000

Under this alternative, EOS would be injected into the subsurface via DPT injection points and injection wells. A high-pressure pump capable of a pumping rate of 5 to 10 gallons per minute (gpm) would be necessary to ensure the proper application of the EOS and to minimize application time.

Injection of EOS within the TCE treatment zones will enhance reductive dechlorination as the primary mechanism for chlorinated VOC biodegradation. The general reduction dechlorination sequence is TCE to DCE isomers and then DCE to VC. Thereafter, VC reduces to ethene and eventually to carbon dioxide, water, and chloride ions via mineralization. The potential for VC to accumulate or reductive dechlorination processes to “stall” as DCE isomers may occur when these constituents are generated at a faster rate than they are degraded. If accumulation or degradation stall of TCE daughter products occurs during implementation of anaerobic bioremediation, a bioagumentation program using DHC inoculum may be implemented to complete the degradation pathway.

Prior to the remedial design, groundwater samples would be collected from monitoring wells that have COC concentrations greater than PRGs, and possibly from wells downgradient of these wells, to determine the presence of contamination. Downgradient and sidegradient monitoring wells would be used to monitor the progress and effectiveness of EOS. In the first year, samples would be collected quarterly and analyzed for field parameters and COCs. After the first year, samples would be collected and analyzed annually. Details for the short-term performance monitoring will be determined as part of the remedial design.

Water level measurements obtained during the RI indicate that shallow groundwater within the vicinity of the treatment area discharges to the two 42-inch stormwater sewers located west of Hangar 2. Although EOS is not expected to transport far beyond the injection points due to the substrate's high viscosity, the area around the two 42-inch stormwater sewers and adjacent monitoring wells will be monitored to determine if any discharge of EOS into the stormwater sewer occurs. Appropriate adjustments to injection rates and dosages could be made to control injections to minimize downstream flow.

ORC would be injected into the NNPA plume to facilitate enhanced aerobic bioremediation of this COC. Delivery of ORC into the subsurface would be performed in a similar manner to EOS. The estimated number of injection points and wells and the quantity of ORC injected is summarized below.

Plume Location (Depth Interval, feet bgs)	Number of Injection Locations	Total ORC Added, pounds	Total Water Added, gallons
NNPA (10 to 20)	3	150	60

Monitoring during the aerobic bioremediation step would be similar to that for the anaerobic bioremediation step discussed above.

Approximately 20 years would be required to meet PRGs within the treatment zone. Five-year reviews would be performed as long as contaminants are present at concentrations that prevent unrestricted site use.

The proposed arrangements of the injections are illustrated on Figure 4-3. Conceptual design calculations are provided in Appendix D.

Note that several injection points are within the footprint of Building 41. Asbestos-containing material is present inside the building and must be addressed prior to demolition of the structure. The need for, timing, and costs of the demolition and asbestos remediation and its effects on groundwater remediation, if any, will be determined during the Remedial Design.

Component 2: LUCs

This component would be identical to Component 2 of Alternative G-2.

Component 3: Monitored Natural Attenuation

Natural attenuation would rely on naturally occurring processes within the aquifer to reduce the concentrations of COCs and restore the aquifer to its beneficial use. Monitored natural attenuation activities would be conducted in accordance with OSWER directive 9200.4-17P.

Natural attenuation monitoring would consist of collecting groundwater samples from monitoring well locations in the deep and shallow TCE plumes. TCE and daughter products of TCE would be monitored within existing monitoring wells to the extent possible. If necessary, additional monitoring wells would be installed. In addition, natural attenuation parameters would be monitored [ORP, DO, pH, alkalinity, temperature, conductivity, TOC, ferrous and total iron, sulfur compounds (sulfide and sulfate), nitrogen compounds (nitrite and nitrate), orthophosphate, chloride, and metabolic gases (methane, ethane, ethane, and carbon dioxide)]. Thirteen wells are assumed to be needed for MNA monitoring. While the costing estimates in Appendix F are based on the information above, details such as the number and location of monitoring wells, analytes, and monitoring frequency, will be determined during development of the long-term monitoring plan as part of the remedial design. Sampling frequency would be quarterly for the first year, semi-annually for the next 2 years, and annually thereafter. Prior to the remedial design and preparation of the long-term monitoring plan, a baseline sampling event would be conducted. Groundwater samples would be collected from monitoring wells that have COC concentrations greater than PRGs to determine the presence of contamination and establish baseline conditions.

The baseline sampling even would also include collection of samples from selected monitoring wells for arsenic, manganese, MTBE, and PCB analysis. If PCBs are detected, further investigation or remedial action for PCBs in groundwater would be considered.

4.2.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-3 would be protective of human health and the environment.

By actively treating the deep and shallow areas containing TCE, 1,1,1-TCA, and 1,1-DCA contamination via anaerobic bioremediation, the expansion of the plumes and contaminant mass would be significantly reduced. Aerobic bioremediation would reduce concentrations of NNPA. This would significantly reduce risk from exposure to contaminated groundwater and provide protection to future human receptors that may be exposed during intrusive activities.

Performance monitoring during the remedial action would be protective by evaluating the effectiveness of in-situ treatment, detecting potential migration of COCs in groundwater, and monitoring levels of MTBE and manganese. Should the monitoring indicate increasing concentrations of redox sensitive metals (e.g. iron and manganese) due to anaerobic conditions, contingency actions may be implemented. Such measures could include the addition of an oxygen source, e.g., oxygen-releasing compound, pure oxygen injection, etc., to increase the ORP and decrease the solubility of these metals. Monitoring of PCBs would provide protection to human health and the environment by further evaluating the presence of this parameter. If PCBs are detected in future sampling rounds additional investigation and/or groundwater treatment would be considered.

Although COCs have not been detected in surface water at concentrations above water quality criteria, there is a possibility that contamination could migrate at low concentrations into the 42-inch stormwater drainage system or surface water. Contingency action(s) may be implemented if COCs are detected in stormwater or surface water at concentrations above water quality criteria. Examples of possible actions include: hydraulic barriers; in-situ treatment (such as oxidation); and other processes (e.g., air sparging, pure oxygen injection, or oxygen-releasing compound) to introduce oxygen to the groundwater to decrease the solubility of iron and manganese.

LUCs would be protective of human health and the environment during the remedial period until PRGs are met. Once the PRGs have been achieved, the human health risk will be calculated using the groundwater monitoring data to determine whether the concentrations result in excess human health risk. Restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater.

Compliance with ARARs and TBCs

Alternative G-3 would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ treatment and natural attenuation. Alternative G-3 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-3 are listed in Tables 4-8, 4-9, and 4-10, respectively.

Long-Term Effectiveness and Permanence

Alternative G-3 would provide long-term effectiveness and permanence.

Alternative G-3 would effectively remove the groundwater contamination present on-site. Enhanced bioremediation is a relatively well-established technology, but its site-specific effectiveness for treatment would have to be verified through pilot-scale treatability testing.

Groundwater use restrictions would effectively prevent the use of aquifer groundwater until the cleanup goals are met.

Monitoring would be an effective means to evaluate the progress of remediation, monitor the absence or presence of PCBs, confirm that no migration of COCs is occurring, and monitor levels of MTBE and manganese. Daughter products of TCE degradation that also have a high toxicity, such as vinyl chloride, may persist and will also be monitored.

The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-3 would effectively reduce the toxicity and volume of the contaminated groundwater. Monitoring during the remedial action would be an effective means to evaluate the progress of remediation and determine that no migration of COCs is occurring. In-situ enhanced bioremediation is a relatively well-established technology. However, prior to final design of the approach described within Alternative G-3, a pilot-scale treatability study would need to be performed.

It is anticipated that during each treatment component the following COC mass would permanently and irreversibly be removed:

- Anaerobic bioremediation:
    - Shallow groundwater – 0.007 pound of COCs (TCE)
    - Shallow groundwater – 0.035 pound of COCs (1,1,1-TCA and 1,1-DCA)
    - Deep groundwater – 0.31 pound of COCs (TCE)

- Aerobic bioremediation:
    - Shallow groundwater – $2x10^{-5}$ pound of COCs (NNPA)

The reducing conditions may also increase the solubility of iron and manganese and may increase the concentration of manganese in the vicinity of the treatment zone. The additional manganese may result in an extension of the period of time for manganese monitoring.

Short-Term Effectiveness

Alternative G-3 would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during installation of injection wells, reagent injection, and groundwater sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of LUCs and monitoring would not adversely impact the surrounding community or the environment.

The environmental footprint of each of the impact categories evaluated using SiteWise™ is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. Overall, Alternative G-3 has a moderate impact on sustainability. Emissions of CO_2, CH_4, and N_2O were normalized to CO_2e. Alternative G-3 contained moderate CO_2e emissions (120 tons), largely due to emissions from EOS manufacture, transportation, and drilling equipment. Criteria pollutants associated with Alternative G-3 for NO_x, SO_x, and PM_{10} emissions were 0.15, 0.16, and 0.0096 tons, respectively. For the three criteria pollutants, the highest contributor to the emissions is the use of laboratory analytical services during the timeline of this alternative. Energy demand for Alternative G-3 was low (7,500 MMBTUs), and was largely associated with equipment and material transport and EOS manufacture. Water usage associated with EOS production resulted in moderate to high water usage impact.

Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs, provided the LUCs are implemented until RAO Nos. 2 and 3 are achieved. The installation of injection wells and injection of EOS and ORC substrates would be completed in approximately 3 months during the first event and during EOS injection events conducted every 5 years in the deep TCE plume. It is estimated that Alternative G-3 would require approximately 20 to 25 years to achieve RAO No. 2 for the VOCs within the treatment zone. Natural attenuation of the balance of the plume would take approximately 20 to 25 years to achieve RAO No. 3 and permanently achieve RAO No. 1 for the VOCs. Time frame estimates are based on the Biochlor model results in Appendix D. The time for manganese concentrations to reach its PRG is uncertain, so monitoring for manganese is assumed to be required for the entire 30-year cost evaluation period.

Implementability

Alternative G-3 would be readily implementable.

The injection locations could be readily installed for in-situ enhanced bioremediation treatment. The number of qualified contractors would be somewhat limited but not overly restrictive. Sampling and maintenance of existing monitoring wells, implementation of LUCs, and the performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The effectiveness and design of the in-situ bioremediation would have to be confirmed through technology-specific sampling and pilot-scale treatability testing. Because of the small number of ORC injection points, no treatability testing is proposed in the NNPA treatment zone. The design will also take into account the locations of existing subsurface utilities and storm sewer lines.

The administrative aspects of Alternative G-3 would be relatively simple to implement. If a change in ownership of the site occurs, appropriate provisions would be incorporated into the property transfer documents to ensure continued implementation of aquifer use restrictions and monitoring. Injections and operations associated with reagent injection would only have to comply with the substantive requirements of any identified ARARs.

Implementation of Alternative G-3 would have an impact on development for 25 years during the enhanced bioremediation process. Implementation of monitoring would result in a long-term development impact until PRGs are met.

Cost

The estimated costs for Alternative G-3 are as follows:

Capital Cost:	$1,164,000
NPW of O&M Costs:	$1,607,000
NPW:	$2,771,000

NPW is based on 30 years. A detailed breakdown of estimated costs for this alternative is provided in Appendix F.

4.2.5 Alternative G-4: Monitored Natural Attenuation and LUCs

4.2.5.1 Description

Alternative G-4 would consist of two major components: (1) monitored natural attenuation and (2) LUCs.

Component 1: Monitored Natural Attenuation

Natural attenuation would rely on naturally occurring processes within the aquifer to reduce the concentrations of TCE, 1,1,1-TCA, 1,1-DCA, NNPA, and manganese. Monitored natural attenuation activities would be conducted according to the requirements of OSWER Directive 9200.4-17P. Contaminant concentrations would be reduced through biological activity, dispersion, and dilution through aquifer movement and adsorption on soil particles. Aquifer conditions would be continually monitored to ensure that concentrations are being adequately reduced through natural processes.

Overall, natural attenuation monitoring would consist of collecting groundwater samples from 7 existing and 6 new monitoring wells for analysis of TCE, 1,1,1-TCA, 1,1-DCA, NNPA, and the natural attenuation parameters: ORP, DO, pH, alkalinity, temperature, conductivity, TOC, ferrous and total iron, sulfur compounds (sulfide and sulfate), nitrogen compounds (nitrite and nitrate), orthophosphate, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide). Samples would be collected from selected monitoring wells for manganese, MTBE, and PCBs. Sampling frequency would be quarterly for the first year, semi-annual for the next 2 years, and annual thereafter. Thirteen wells are assumed to be needed for MNA monitoring. While the costing estimates in Appendix F are based on the information above, details such as the number and location of monitoring wells, analytes and monitoring frequency, will be determined during development of the long-term monitoring plan as part of the remedial design. Prior to the remedial design and preparation of the long-term monitoring plan, a baseline sampling event would be conducted. Groundwater samples would be collected from existing monitoring wells that have COC concentrations greater than PRGs to determine the presence of contamination and establish baseline conditions. The baseline sampling event would also include collection of samples from selected monitoring wells for PCB and MTBE analysis.

Based on preliminary modeling using Biochlor, it is estimated that PRGs for VOCs would be achieved in 40 to 60 years. Calculations supporting Biochlor modeling are included in Appendix D. Five-year reviews would be performed as long as contaminants are present at concentrations that prevent unrestricted site use.

<u>Component 2: LUCs</u>

This component would be identical to Component 2 of G-2.

4.2.5.2 Detailed Analysis

<u>Overall Protection of Human Health and the Environment</u>

Alternative G-4 would be protective of human health and the environment.

Naturally occurring processes such as biodegradation, dispersion, and dilution would reduce concentrations of groundwater COCs to their PRGs over the long term. However, it would be approximately 40 to 60 years before these processes achieve the PRGs, and the risk from exposure to contaminated groundwater would be addressed through LUCs, which would effectively prevent unacceptable risk from exposure until the PRGs have been met. Once the PRGs have been achieved, the human health risk will be calculated using the groundwater monitoring data to determine whether the concentrations result in excess human health risk. Monitored natural attenuation would be protective of the environment by evaluating the progress of natural attenuation and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required. Collection of samples from selected monitoring wells for manganese, MTBE and PCBs would provide protection of human health and the environment by further evaluating the presence of these chemicals. If PCBs are detected, further investigation or remedial action for PCBs in groundwater would be considered.

Although COCs have not been detected in surface water at concentrations above water quality criteria, there is a possibility that contamination could migrate at low concentrations into the 42-inch stormwater drainage system or surface water. Contingency action(s) may be implemented if COCs are detected in stormwater or surface water at concentrations above water quality criteria. Examples of possible actions include: hydraulic barriers; in-situ treatment (such as oxidation); and other processes (e.g., air sparging, pure oxygen injection, or oxygen-releasing compound) to introduce oxygen to the groundwater to decrease the solubility of iron and manganese.

LUCs would be protective of human health and the environment. Restricting the use of aquifer groundwater would be protective of human health by preventing unacceptable risks from exposure to contaminated groundwater.

No adverse short-term or cross-media effects are anticipated as a result of implementing this alternative.

<u>Compliance with ARARs and TBCs</u>

Alternative G-4 would eventually comply with chemical-specific ARARs and TBCs through natural attenuation. Alternative G-4 would also comply with location- and action-specific ARARs and TBCs. In the short-term, this alternative would not comply with chemical-specific ARARs, but would eventually. Compliance would be achieved as natural processes within the aquifer to reduce concentrations of COCs below the PRGs. This would be confirmed through monitoring. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-4 are listed in Tables 4-11, 4-12, and 4-13, respectively.

<u>Long-Term Effectiveness and Permanence</u>

Alternative G-4 would provide long-term effectiveness and permanence through natural attenuation of the COCs. Natural attenuation would effectively and permanently reduce groundwater contaminant concentrations to acceptable levels.

Monitoring the progress of natural attenuation would be an effective means to evaluate the remedial progress and determine that no migration of COCs is occurring, monitor the absence or presence of PCBs, and monitor levels of MTBE and manganese. Daughter products of TCE degradation that also have a high toxicity, such as vinyl chloride, may persist and will also be monitored. If the monitoring results indicate poor progress in achieving the remedial goals, bioaugmentation may be needed to provide the microbial population and/or electron donor to enhance the naturally occurring processes and achieve the remedial goals in an acceptable time frame.

Groundwater use restrictions would effectively prevent the use of groundwater until human-health risks are mitigated.

The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-4 does not include treatment. Alternative G-4 would reduce the toxicity, mobility, and volume of groundwater COCs. The mass of COCs that would be degraded through biological and abiotic processes during natural attenuation is uncertain.

No treatment residuals would be generated by this alternative.

Short-Term Effectiveness

Alternative G-4 would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during groundwater sampling would be minimized by compliance with the requirements of the OSHA, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of LUCs would not adversely impact the surrounding community or the environment.

The environmental footprint of each of the impact categories evaluated using SiteWise™ is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. Overall, Alternative G-3 has a low impact on sustainability. Emissions of CO_2, CH_4, and N_2O were normalized to CO_2e. Alternative G-4 contained moderate CO_2e emissions (42 tons), largely due to emissions associated with laboratory analytical services. Criteria pollutants associated with Alternative G-4 for NO_x, SO_x, and PM_{10} emissions were 0.12, 0.081, and 0.0038 tons, respectively. The highest contributor to the criteria pollutants is the laboratory analytical service. Energy demand for Alternative G-4 was low (630 MMBTUs) and was largely attributed to the energy demand associated with the laboratory analytical services. Water usage associated with the production of PVC resulted in low water usage impacts.

Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs, provided the LUCs are implemented until RAO Nos. 2 and 3 are achieved. Natural attenuation of the plume would take approximately 40 to 60 years to achieve RAO Nos. 2 and 3 and permanently achieve RAO No. 1 for the VOCs. The time for manganese concentrations to reach its PRG is uncertain, so monitoring for manganese is assumed to be required for the entire 30-year cost evaluation period.

Implementability

Sampling and maintenance of the existing monitoring wells during monitored natural attenuation and performance of 5-year reviews during the lifecycle of Alternative G-4 could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The administrative aspects of Alternative G-4 could be more difficult than the other alternatives to implement if a change in ownership of the site occurs prior to completion of remediation. Appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of aquifer use restrictions and monitoring.

Implementation of Alternative G-4 would have an impact on development during monitoring, which could impact long-term development for approximately 40 to 60 years.

Cost

The estimated costs for Alternative G-4 are as follows:

Capital Cost:	$ 186,000
NPW of Annual Costs:	$ 1,111,000
NPW:	$ 1,297,000

NPW is based on 30 years. A detailed breakdown of estimated costs for this alternative is provided in Appendix F.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-1
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks caused by exposure to contaminants will not be addressed.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential non-carcinogenic hazards caused by exposure to contaminants will not be addressed.
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	To Be Considered	Guidelines for assessing cancer risk	This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks caused by exposure to contaminants will not be addressed.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	To Be Considered	Guidance for assessing cancer risks in children	This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks to children caused by exposure to contaminants will not be addressed.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-1
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 USC § 300f *et seq.;* 40 CFR 141, Subpart G	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	The No-Action alternative will not achieve these standards.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals	42 USC § 300f *et seq.;* 40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only;	Establishes maximum contaminant level goals (MCLGs) for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	The No-Action alternative will not achieve these standards.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-1
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	The No-Action alternative will not achieve this guideline.
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establish enforceable state MCLs for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water systems. Will be used where state standard is more stringent than federal standard. Also establishes state MCLGs which are non-enforceable health goals for public drinking water systems.	The No-Action alternative will not achieve these standards.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	To Be Considered	Establishes enforceable water quality standards for surface water.	The No-Action alternative will not achieve these standards.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through chemical oxidation combined with natural attenuation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential non-carcinogenic risks through chemical oxidation combined with natural attenuation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	To Be Considered	Guidelines for assessing cancer risk	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through chemical oxidation combined with natural attenuation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	To Be Considered	Guidance for assessing cancer risks in children	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks to children through chemical oxidation combined with natural attenuation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 USC § 300f *et seq.;* 40 CFR 141, Subpart B	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	This alternative will achieve MCL standards through treatment of groundwater by chemical oxidation combined with natural attenuation. Land use controls will prevent short-term exposure until MCL standards are reached.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals	42 USC § 300f *et seq.;* 40 CF. 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only	Establishes maximum contaminant level goals (MCLGs) for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	This alternative will achieve MCLG standards through treatment of groundwater by chemical oxidation combined with natural attenuation. Land use controls will prevent short-term exposure until MCLG standards are reached.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by natural attenuation. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where background concentration is greater than HA value.
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establish enforceable state MCLs for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water systems. Will be used where state standard is more stringent than federal standard. Also establishes state MCLGs which are non-enforceable health goals for public drinking water systems.	This alternative will achieve state MCL and MCLG standards through treatment of groundwater by chemical oxidation combined with natural attenuation. Land use controls will prevent short-term exposure until state MCL and MCLG standards are reached.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	To Be Considered	Establishes enforceable water quality standards for surface water.	Surface water monitoring will be performed for this alternative to ensure protection to surface water.

TABLE 4-3

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
There are no federal location-specific ARARs.				
State				
Massachusetts Endangered Species Act	M.G.L. ch.,131A 321 C.M.R. 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the Building 82 site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 *et seq*.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Underground Injection Control	40 CFR 144, 146, 147.1100	Relevant and Appropriate	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of chemical substances into the groundwater. In-situ treatment using chemical oxidation will be conducted in compliance with these standards.
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites	OSWER Directive 9200.4-17P (April 21, 1999)	To Be Considered	EPA guidance regarding the use of monitored natural attenuation for the cleanup of contaminated soil and groundwater. In particular, a reasonable time frame for achieving cleanup standard through monitored attenuation would be comparable to that which could be achieved through active restoration.	This monitored natural attenuation component will only meet these standards if natural attenuation will attain all groundwater cleanup standards within a reasonable time frame, estimated to be 20 to 25 years.

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Clean Air Act National Emission Standards for Hazardous Air Pollutants	42 USC § 112(b)(1) et seq. 40 CFR Part 61	Applicable	Regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive emissions and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste that is generated as part of this remedial action is classified as hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions involve underground injection, such as an oxidizer for in-situ chemical oxidation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and to the accumulation of waste prior to off-site disposal.	Wastes generated during remedial actions that are determined to be hazardous will be handled in compliance with the substantive requirements of these regulations.

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of an oxidizer for in-situ chemical oxidation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.
Erosion and Sediment Control Guidance	-	To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential non-carcinogenic risks through chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	To Be Considered	Guidelines for assessing cancer risk	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	To Be Considered	Guidance for assessing cancer risks in children	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks to children through chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure to COCs in groundwater until risk-based cleanup goals are achieved.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 USC § 300f *et seq.;* 40 CFR 141, Subpart B	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	This alternative will achieve MCL standards through treatment of groundwater by chemical oxidation. Land use controls will prevent short-term exposure until MCL standards are reached.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals	42 USC § 300f *et seq.;* 40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only	Establishes maximum contaminant level goals (MCLGs) for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	This alternative will achieve MCLG standards through treatment of groundwater by chemical oxidation. Land use controls will prevent short-term exposure until MCLG standards are reached.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by natural attenuation. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where background concentration is greater than HA value.
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establish enforceable state MCLs for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water systems. Will be used where state standard is more stringent than federal standard. Also establishes state MCLGs which are non-enforceable health goals for public drinking water systems.	This alternative will achieve state MCL and MCLG standards through treatment of groundwater by chemical oxidation. Land use controls will prevent short-term exposure until state MCL and MCLG standards are reached.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	To Be Considered	Establishes enforceable water quality standards for surface water.	Surface water monitoring will be performed for this alternative to ensure protection to surface water.

TABLE 4-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
There are no federal location-specific ARARs.				
State				
Massachusetts Endangered Species Act	M.G.L. ch.,131A 321 C.M.R. 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the Base, but not at the Building 82 site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 *et seq*.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Underground Injection Control	40 CFR 144, 146, 147.1100	Relevant and Appropriate	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of chemical substances into the groundwater. In-situ treatment using chemical oxidation will be conducted in compliance with these standards.
Clean Air Act National Emission Standards for Hazardous Air Pollutants	42 USC § 112(b)(1) et seq. 40 CFR Part 61	Applicable	Regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive emissions and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste that is generated as part of this remedial action is classified as hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions involve underground injection, such as an oxidizer for in-situ chemical oxidation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and to the accumulation of waste prior to off-site disposal.	Wastes generated during remedial actions that are determined to be hazardous will be handled in compliance with the substantive requirements of these regulations.
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of an oxidizer for in-situ chemical oxidation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2A
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Erosion and Sediment Control Guidance	-	To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through bioremediation and chemical oxidation will address long-term risk, while land use control will prevent short-term exposure until risk-based cleanup goals are achieved.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential non-carcinogenic risks through bioremediation and chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure until risk-based cleanup goals are achieved.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	To Be Considered	Guidelines for assessing cancer risk	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks through bioremediation and chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure until risk-based cleanup goals are achieved.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	To Be Considered	Guidance for assessing cancer risks in children	This alternative will meet the risk-based cleanup goals developed through the use of this guidance since treating groundwater that poses potential carcinogenic risks to children through bioremediation and chemical oxidation will address long-term risk, while land use controls will prevent short-term exposure until risk-based cleanup goals are achieved.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 USC § 300f *et seq.;* 40 CFR 141, Subpart G	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	This alternative will achieve MCL standards through treatment of groundwater by bioremediation and chemical oxidation. Land use controls will prevent short-term exposure until MCL standards are reached.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals	42 USC § 300f *et seq.;* 40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only;	Establishes maximum contaminant level goals (MCLGs) for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	This alternative will achieve MCLG standards through treatment of groundwater by bioremediation and chemical oxidation. Land use controls will prevent short-term exposure until MCLG standards are reached.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by natural attenuation. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where background concentration is greater than HA value.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establish enforceable state MCLs for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water systems. Will be used where state standard is more stringent than federal standard. Also establishes state MCLGs which are non-enforceable health goals for public drinking water systems.	This alternative will achieve state MCL and MCLG standards, which are more stringent than federal standards through treatment of groundwater by bioremediation and chemical oxidation. Land use controls will prevent short-term exposure until state MCL and MCLG standards are reached.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	To Be Considered	Establishes enforceable water quality standards for surface water.	Surface water monitoring will be performed for this alternative to ensure protection to surface water.

TABLE 4-9

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
There are no federal location-specific ARARs.				
State				
Massachusetts Endangered Species Act	M.G.L. ch. 131A; 321 C.M.R. 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the Building 82 site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 *et seq*.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Underground Injection Control	40 CFR 144, 146, 147.1100	Relevant and Appropriate	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of biological or chemical substances into the groundwater. In-situ treatment using bioremediation and chemical oxidation will be conducted in compliance with these standards.
Clean Air Act National Emission Standards for Hazardous Air Pollutants	42 USC § 112(b)(1) et seq. 40 CFR Part 61	Applicable	Regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive emissions and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites	OSWER Directive 9200.4-17P (April 21, 1999)	To Be Considered	EPA guidance regarding the use of monitored natural attenuation for the cleanup of contaminated soil and groundwater. In particular, a reasonable time frame for achieving cleanup standard through monitored attenuation would be comparable to that which could be achieved through active restoration.	This monitored natural attenuation alternative will only meet these standards if natural attenuation will attain all groundwater cleanup standards within a reasonable time frame, estimated to be 20 to 25 years.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions involve underground injection, such as an electron donor for bioremediation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Hazardous wastes generated as part of the remedial action will be handled in compliance with the requirements of these regulations.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of bioremediation agents and oxidizers for in-situ chemical oxidation. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.
Erosion and Sediment Control Guidance	-	To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	This alternative will only meet the standard developed through the use of this guidance if the COCs in groundwater that pose potential carcinogenic risks naturally attenuate within a reasonable period of time. Land use controls will prevent short-term exposure to COCs in groundwater until risk-based standards are achieved.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	To Be Considered	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	This alternative will only meet the standard developed through the use of this guidance if the COCs in groundwater that pose potential carcinogenic risks naturally attenuate within a reasonable period of time. Land use controls will prevent short-term exposure to COCs in groundwater until risk-based standards are achieved.
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	To Be Considered	Guidelines for assessing cancer risk	This alternative will only meet the standard developed through the use of this guidance if the COCs in groundwater that pose potential carcinogenic risks naturally attenuate within a reasonable period of time. Land use controls will prevent short-term exposure to COCs in groundwater until risk-based standards are achieved.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by natural attenuation. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where background concentration is greater than HA value.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	To Be Considered	Guidance for assessing cancer risks in children	This alternative will only meet this standard if groundwater that poses potential carcinogenic risks to children will naturally attenuate within a reasonable period of time. Land use controls will prevent short-term exposure until risk-based standards are achieved.
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Levels	42 USC § 300f *et seq.;* 40 CFR 141, Subpart B	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources	This alternative will only meet this standard if groundwater naturally attenuates and meets MCL standards within a reasonable time frame. Land use controls will prevent short-term exposure until MCL standards are reached.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations, Maximum Contaminant Level Goals	42 USC § 300f *et seq.;* 40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only.	Establishes maximum contaminant level goals (MCLGs) for public water supplies. Non-zero MCLGs are health goals for public drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds. MCLGs are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used as cleanup goals when MCLs have not been established for a particular COC.	This alternative will only meet this standard if groundwater naturally attenuates and meets MCLG standards within a reasonable time frame. Land use controls will prevent short-term exposure until MCLG standards are reached.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Drinking Water Regulations	310 CMR 22.00	Relevant and Appropriate	Establish enforceable state MCLs for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water systems. Will be used where state standard is more stringent than federal standard. Also establishes state MCLGs which are non-enforceable health goals for public drinking water systems.	This alternative will only meet this standard if groundwater naturally attenuates and meets state MCL and MCLG standards within a reasonable time frame. Land use controls will prevent short-term exposure until state MCL and MCLG standards are reached.
Massachusetts Surface Water Quality Standards	314 CMR 4.00	To Be Considered	Establishes enforceable water quality standards for surface water.	Surface water monitoring will be performed for this alternative to ensure protection to surface water.

TABLE 4-12

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
There are no federal location-specific ARARs.				
State				
Massachusetts Endangered Species Act	M.G.L. Ch. 131A; 321 C.M.R. 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the Building 82 site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 *et seq*.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites	OSWER Directive 9200.4-17P (April 21, 1999)	To Be Considered	EPA guidance regarding the use of monitored natural attenuation for the cleanup of contaminated soil and groundwater. In particular, a reasonable time frame for achieving cleanup standard through monitored attenuation would be comparable to that which could be achieved through active restoration.	This monitored natural attenuation alternative will only meet these standards if natural attenuation will attain all groundwater cleanup standards within a reasonable time frame. It is estimated that all cleanup standards will be achieved in 40 to 60 years.
Clean Air Act National Emission Standards for Hazardous Air Pollutants	42 USC § 112(b)(1) et seq. 40 CFR Part 61	Applicable	Regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive emissions and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.

TABLE 4-13

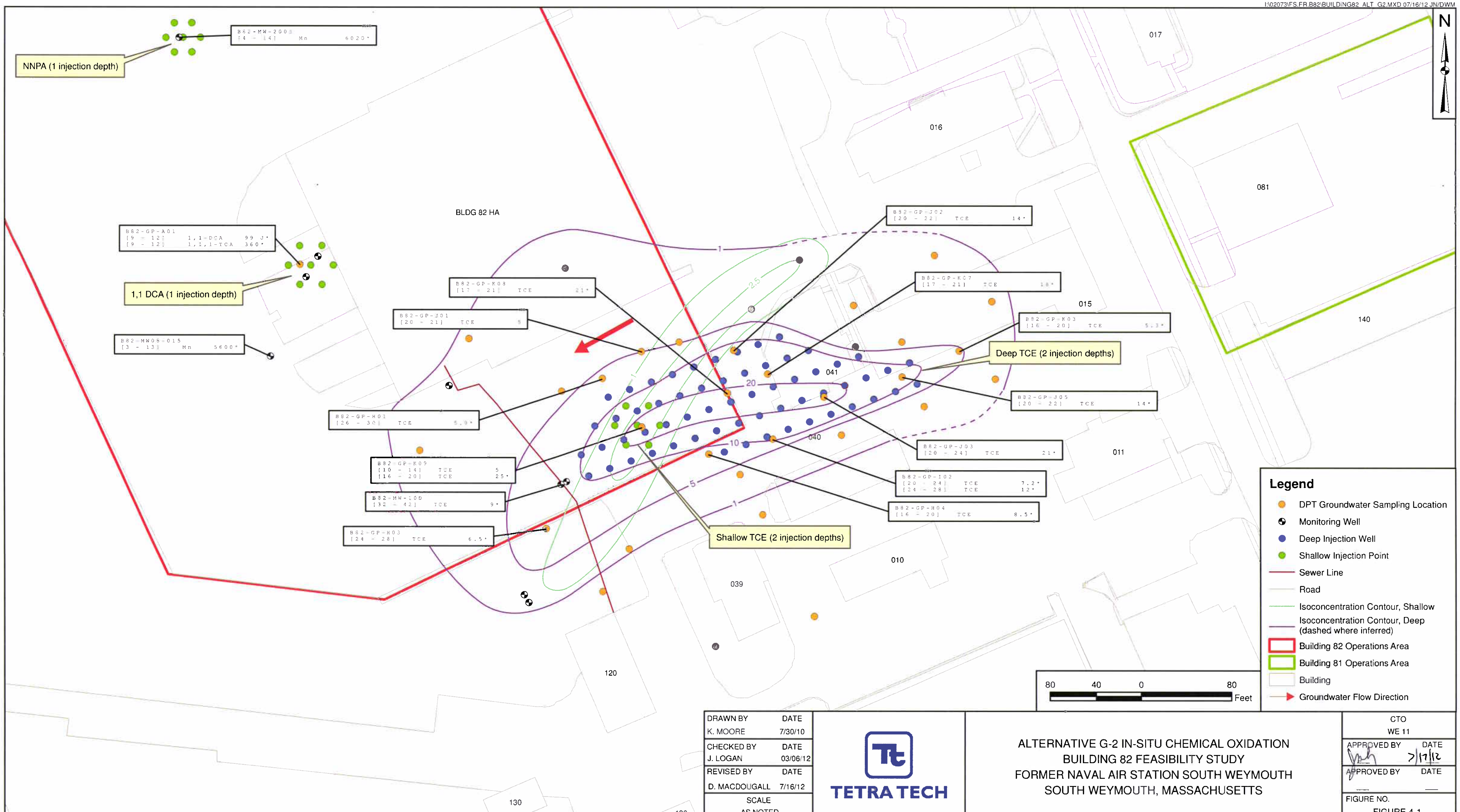
FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes	310 CMR 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and to the accumulation of waste prior to off-site disposal.	Wastes generated during remedial actions that are determined to be hazardous will be handled in compliance with the substantive requirements of these regulations.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-4
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Erosion and Sediment Control Guidance	-	To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.

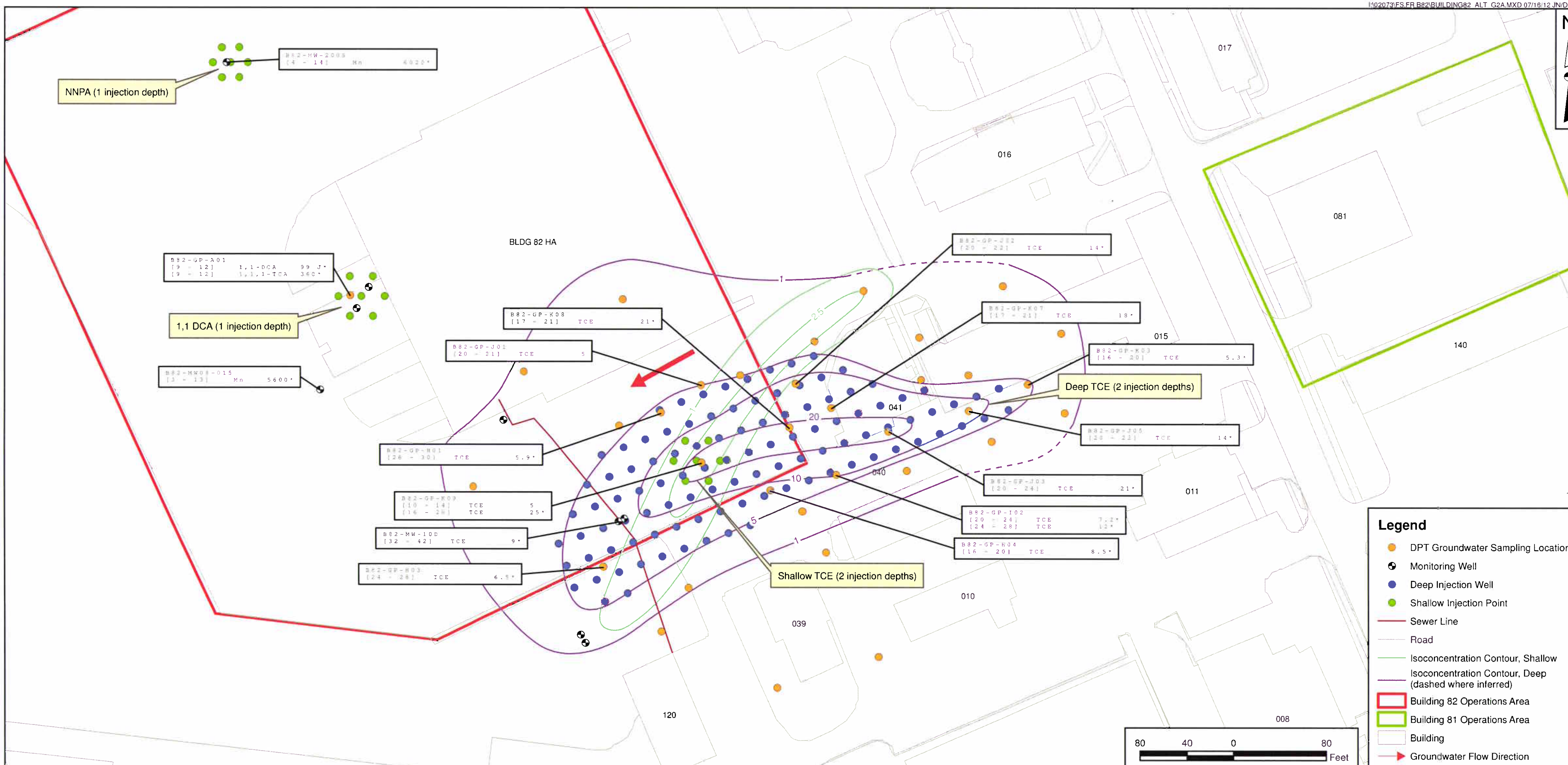


DRAWN BY	DATE
K. MOORE	7/30/10
CHECKED BY	DATE
J. LOGAN	03/06/12
REVISED BY	DATE
D. MACDOUGALL	7/16/12
SCALE AS NOTED	

TETRA TECH

ALTERNATIVE G-2 IN-SITU CHEMICAL OXIDATION
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

CTO WE 11	
APPROVED BY	DATE 7/17/12
APPROVED BY	DATE
FIGURE NO.	FIGURE 4-1

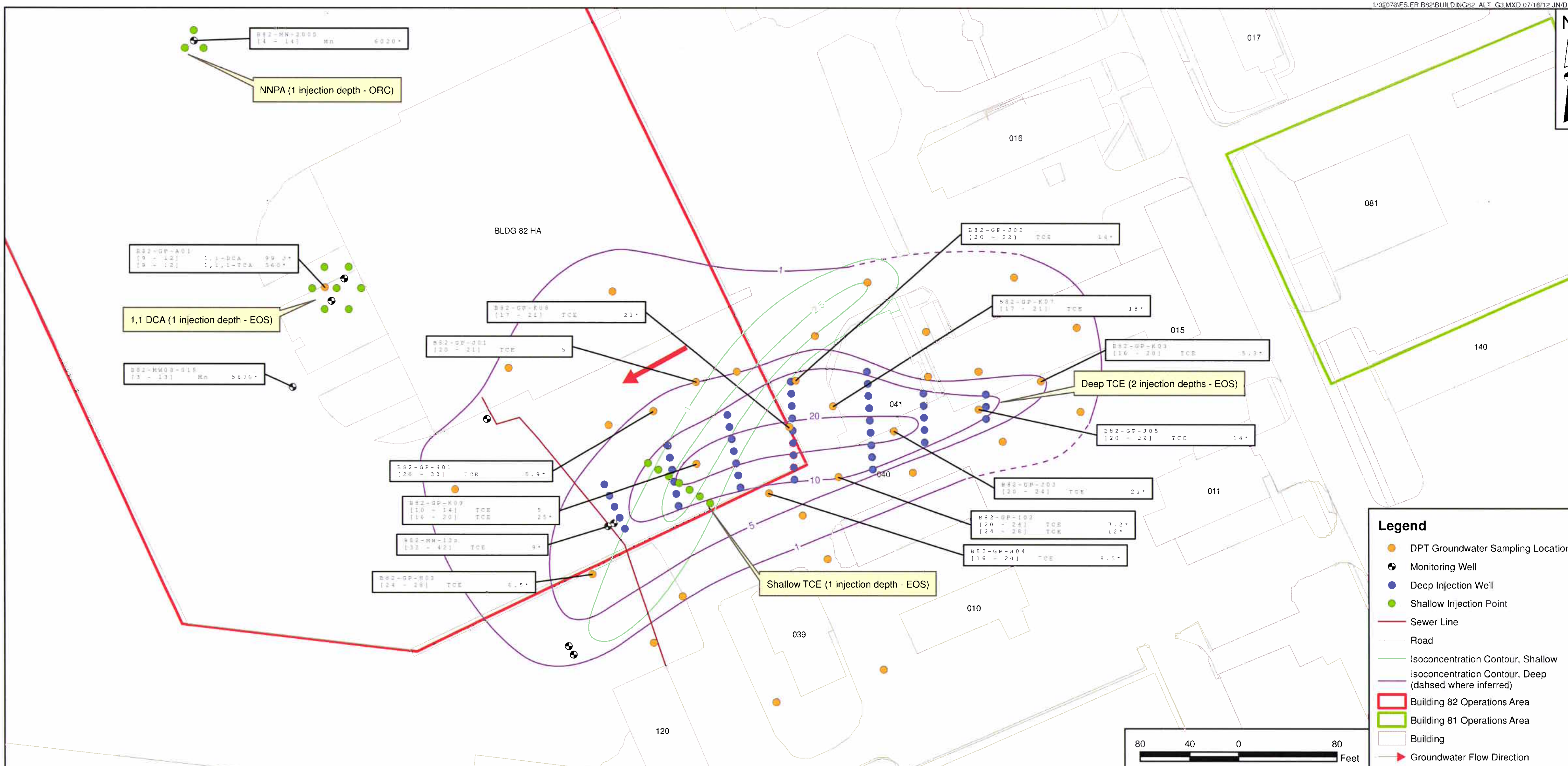


DRAWN BY	DATE
K. MOORE	7/30/10
CHECKED BY	DATE
J. LOGAN	03/06/12
REVISED BY	DATE
D. MACDOUGALL	7/16/12
SCALE AS NOTED	

TETRA TECH

ALTERNATIVE G-2A IN-SITU CHEMICAL OXIDATION - ENTIRE PLUME
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

CTO WE 11	
APPROVED BY	DATE
JWL	7/17/12
APPROVED BY	DATE
FIGURE NO. FIGURE 4-2	



DRAWN BY	DATE
K. MOORE	7/30/10
CHECKED BY	DATE
J. LOGAN	03/05/12
REVISED BY	DATE
D. MACDOUGALL	7/16/12
SCALE AS NOTED	

TETRA TECH

ALTERNATIVE G-3 ENHANCED BIOREMEDIATION
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
SOUTH WEYMOUTH, MASSACHUSETTS

CTO WE 11	
APPROVED BY	DATE
JWL	7/17/12
APPROVED BY	DATE
FIGURE NO.	FIGURE 4-3

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the groundwater remedial alternatives presented in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF GROUNDWATER REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for the Building 82 site groundwater are compared in this section:

- Alternative G-1: No Action
- Alternative G-2: Chemical Oxidation, LUCs, and Monitored Natural Attenuation
- Alternative G-2A: Chemical Oxidation, LUCs and Monitoring
- Alternative G-3: In-Situ Enhanced Bioremediation, LUCs, Monitored Natural Attenuation
- Alternative G-4: LUCs and Monitored Natural Attenuation

5.1.1 Overall Protection of Human Health and the Environment

Alternatives G-2, G-2A, G-3, and G-4 would all provide protection to human health and the environment. Alternative G-2A would provide the best protection because chemical oxidation would treat the entire VOC plume in the shortest amount of time. Alternatives G-2 would provide the next best protection because chemical oxidation would treat the COC areas in the shortest amount of time. Alternative G-3 provides the next best protection due to the relatively longer time required for COCs to pass through the treatment areas/barriers. In Alternative G-4, COCs would persist for the longest time due to the slower rate of natural attenuation.

Monitoring during Alternatives G-2, G-2A, G-3, and G-4 would be effective in detecting the potential migration of the plume and in monitoring the progress of the remediation. The natural attenuation component of Alternative G-4 would reduce contaminant concentrations. This would significantly reduce the risk from exposure to contaminated groundwater. LUCs would provide protection of human health by restricting the use of groundwater until PRGs are met.

Alternative G-1 would provide no protection of human health and the environment; groundwater contamination might migrate off site. Because no monitoring would be performed, potential migration of COCs would not be detected.

Although COCs have not been detected in surface water at concentrations above water quality criteria, there is a possibility that contamination could migrate at low concentrations into the 42-inch stormwater drainage system or surface water. Contingency action(s), such as hydraulic barriers, in-situ treatment (such as oxidation), and other processes (e.g. air sparging, ISCO, or oxygen-releasing compound) to introduce oxygen to the groundwater to decrease the solubility of iron and manganese, may be warranted if COCs are detected in surface and/or storm water at concentrations above water quality criteria.

5.1.2 Compliance with ARARs and TBCs

Alternatives G-2, G-2A, G-3, and G-4 would comply with location- and action-specific ARARs and TBCs.

Alternative G-2A would comply with chemical-specific ARARs and TBCs for VOCs shortly after chemical injection is completed. Alternatives G-2, G-3, and G-4 would not immediately comply with chemical-specific ARARs and TBCs, but these alternatives would eventually achieve compliance as they attain PRGs through active treatment and/or natural attenuation. Alternative G-2A would eventually comply with the PRG for manganese.

Alternative G-1 would not comply with chemical-specific ARARs, and compliance with location-specific ARARs would be incidental. Although this alternative may eventually meet chemical-specific ARARs though natural attenuation, there would be no monitoring to confirm this. Action-specific ARARs or TBCs would not apply.

5.1.3 Long-Term Effectiveness and Permanence

Alternatives G-2, G-2A, G-3, and G-4 would provide long-term effectiveness and permanence. Alternatives G-2, G-2A, and G-3 provide essentially equal levels of long-term effectiveness and permanence through a combination of active treatment and LUCs, although Alternative G-2A provides the largest amount of treatment and permanent removal. Alternative G-4 may be less permanent than Alternatives G-2, G-2A, and G-3 because sorption, dilution, and dispersion components of the remedy are likely and may leave a slightly larger mass of COCs at the site in comparison to alternatives involving active treatment. For these four alternatives, LUCs could be maintained until PRGs are met. For Alternatives G-2, G-3, and G-4, daughter products of TCE degradation that also have a high toxicity, such as vinyl chloride, may persist and will also be monitored.

Alternative G-1 would have no long-term effectiveness and permanence since contaminated groundwater would remain on site and there would be no LUCs to restrict site use and building construction methods. Therefore the potential would exist for unacceptable risk for human receptors through groundwater use. Because there would be no groundwater monitoring, potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease to PRGs through natural attenuation, there would be no monitoring to verify this.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives G-2, G-2A, and G-3 and would achieve reductions in COC toxicity and volume through treatment. There is no active treatment in Alternative G-4. Alternative G-1 would not achieve any reduction of toxicity, mobility, or volume of COCs through treatment.

Alternatives G-2 and G-2A would permanently and irreversibly remove an estimated 0.35 pound of COCs (0.317 pound of TCE, 0.03 pound of 1,1,1-TCA, 0.005 pound of 1,1-DCA, and 2.0×10^{-5} pound of NNPA) through chemical oxidation. Alternative G-3 would permanently and irreversibly remove the same amount of COCs as Alternative G-2 through bioremediation.

Alternatives G-2, G-2A, and G-4 are not expected to generate treatment residues of concern assuming complete chemical oxidation of the COCs. For Alternative G-3, the reducing conditions may also increase the solubility and mobility of redox-sensitive metals (e.g. arsenic and manganese) and may increase the concentrations of these compounds in the vicinity of the treatment zone. The additional manganese may result in an extension of the period of time for manganese monitoring.

5.1.5 Short-Term Effectiveness

Under Alternatives G-2, G-2A, G-3, and G-4, potential short-term risk to site workers from exposure to contaminated groundwater during the installation, maintenance, and sampling of new and existing monitoring wells and during active remediation would be effectively avoided by proper planning. Alternative G-4 would result in the lowest short-term risk to site workers, with the potential for exposure only during monitoring well installation and groundwater sampling. Alternative G-3 would result in a higher level of short-term exposure than Alternatives G-2 and G-2A, due to the extended timeframe of injection. During implementation of Alternatives G-2 and G-2A, workers would handle a strong oxidizer. Implementation of Alternatives G-2, G-2A, G-3, and G-4 would not adversely impact the surrounding community or environment.

As discussed in Appendix E, Alternative G-4 is the most sustainable alternative, followed by Alternative G-3, Alternative G-2, and Alternative G-2A.

Alternatives G-2, G-2A, G-3, and G-4 would achieve groundwater RAO No. 1 immediately upon implementation of LUCs and monitoring. Construction activities associated with Alternatives G-2, G-2A, G-3, and G-4 would be completed in less than 3 months. For VOCs, groundwater RAO Nos. 2 and 3 would be attained in approximately 2 years within the treatment zone and 20 to 25 years for the balance of the plume for Alternative G-2, in approximately 5 years for Alternative G-2A, approximately 20 to 25 years for Alternative G-3, and approximately 40 to 60 years for the natural attenuation component of Alternative G-4. Upon completion of natural attenuation, RAO No. 1 would be permanently achieved for VOCs. The time for manganese concentrations to reach its PRG is uncertain, so monitoring for manganese is assumed to be required for the entire 30-year cost evaluation period for Alternatives G-2, G-2A, G-3, and G-4.

Implementation of Alternative G-1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative G-1 would not achieve the RAOs, and although the cleanup goals might eventually be attained through natural processes, this would not be verified.

5.1.6 Implementability

Alternative G-1 would be easiest to implement because there would be no activities required.

Of the remaining three alternatives, Alternative G-4 would be the easiest to implement because of the minimal amount of field work and monitoring that would be required. Alternative G-2 would be easier to implement than G-2A and G-3 since it is assumed that only one injection event will be required. Alternative G-2A would be easier to implement than G-3. For Alternatives G-2 and G-2A, handling of the oxidizing agent adds to the difficulty of implementation. Contractors and equipment are readily available for each alternative. The remedial design will take into account the locations of existing subsurface utilities and storm sewer lines.

The implementation of any of the alternatives will affect the extent to which the site can be developed. Any future development plans must work around or otherwise take into account the presence of the physical components of the remediation components. Alternative G-3 would have the largest impact since EOS injection would occur over a 15 year period of time. Alternatives G-2 and G-2A would have less impact than Alternative G-3, since oxidant injection will occur within a 1 to 2 year timeframe. Natural attenuation components of Alternatives G-2, G-3, and G-4 and monitoring for Alternative G-2A, would have the similar long-term effect as access to monitoring locations would be required for an extended period of time.

Use of the property may be minimally affected by the implementation of the alternatives. Alternatives G-2, G-2A, and G-3 would temporarily impact site use during injection well installation and reagent injection. LUCs would be required until RAO Nos. 2 and 3 are achieved for Alternatives G-2, G-2A, G-3, and G-4, although LUCs would be required for the longest time under Alternative G-4.

5.1.7 Cost

The capital and O&M costs and NPW of the alternatives are as follows.

Alternative	Capital	NPW of Annual Costs	NPW
G-1	$8,000	$109,000 (30 Years)	$117,000 (30 Years)
G-2	$1,615,000	$1,111,000 (30 Years)	$2,727,000 (30 Years)
G-2A	$2,397,000	$875,000 (30 Years)	$3,272,000 (30 Years)
G-3	$1,164,000	$1,607,000 (30Years)	$2,771,000 (30 Years)
G-4	$186,000	$1,111,000 (30 Years)	$1,297,000 (30 Years)

Detailed cost estimates are provided in Appendix F.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the groundwater remedial alternatives.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: In-Situ Chemical Oxidation, LUCs, and MNA	Alternative G-2A: In-Situ Chemical Oxidation, LUCs, and Monitoring	Alternative G-3: Enhanced Bioremediation, In-Situ Chemical Oxidation, LUCs, and MNA	Alternative G-4: LUCS and MNA
Overall Protection of Human Health and Environment	Would offer no protectiveness of human health. Would not be protective of the environment because no action would occur. Migration of COCs would continue and remain undetected.	Would be protective of human health and the environment. Would be slightly less protective as Alternative G-2A and more protective than the other alternatives because the COC areas would be treated in a short time. LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be most protective compared to the other alternatives because the entire VOC plume would be treated in a short time. LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be less protective than Alternatives G-2 and G-2A, and more protective than G-4. TCE concentrations would persist until the plumes move through the EOS barriers. LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be less protective than Alternatives G-2, G-2A, and G-3. The concentrations of COCs would persist for more than 40 years. LUCs would prevent exposure until remediation is complete.
Compliance with ARARs and TBCs: Chemical-Specific Location-Specific Action-Specific	 Would not comply Would not comply Not applicable	 Would eventually comply Would comply Would comply	 Would eventually comply Would comply Would comply	 Would eventually comply Would comply Would comply	 Would eventually comply Would comply Would comply
Long-Term Effectiveness and Permanence	Contaminant reduction or migration would remain undetected because no monitoring would occur.	Would be as permanent and effective as Alternatives G-2A and G-3. Alternative G-2 would be more permanent than Alternative G-4. In-situ chemical oxidation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as Alternatives G-2 and G-3, but provides a larger amount of permanent removal through treatment of the entire plume. Alternative G-2A would be more permanent than Alternative G-4. In-situ chemical oxidation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as Alternatives G-2 and G-2A. Alternative G-3 would be more permanent than Alternative G-4. Enhanced bioremediation would reduce COCs, and LUCs would prevent exposure.	Would be less permanent and effective than Alternatives G-2, G-2A, and G-3, because G-4 relies on sorption, dilution, and dispersion. Biological activity is expected to permanently destroy some portion of COCs, but the quantity is uncertain. Natural attenuation would reduce COCs and LUCs would prevent exposure.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No treatment would occur.	Would permanently reduce contaminant toxicity and volume by removing an estimated 0.35 pound of COCs through in-situ chemical oxidation.	Would permanently reduce contaminant toxicity and volume by removing an estimated 0.35 pound of COCs through in-situ chemical oxidation.	Would permanently reduce contaminant toxicity and volume by removing an estimated 0.35 pound of the remaining COCs through enhanced bioremediation. Reducing conditions may increase the concentration of manganese and extend the period of time for manganese monitoring.	No treatment would occur.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
BUILDING 82 FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: In-Situ Chemical Oxidation, LUCs, and MNA	Alternative G-2A: In-Situ Chemical Oxidation, LUCs, and Monitoring	Alternative G-3: Enhanced Bioremediation, In-Situ Chemical Oxidation, LUCs, and MNA	Alternative G-4: LUCS and MNA
Short-Term Effectiveness	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no action would occur. Since no monitoring would be performed, there would be no way to determine if the RAOs are achieved.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of Fenton's reagent and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. Least potential for short term risks. There would be no risk to the surrounding community or the environment. Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs. Approximately 2 years would be required to treat VOCs within the treatment zone and achieve RAO No. 2. Natural attenuation of the balance of the plume would take approximately 20 to 25 years to achieve RAO No. 3 for VOCs. Monitoring for manganese is assumed to continue for 30 years. Active treatment would be completed in 2 years.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of Fenton's reagent and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. Least potential for short term risks. There would be no risk to the surrounding community or the environment. Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs. Approximately 2 years would be required to treat VOCs within the treatment zone and achieve RAO No. 2. Monitoring would be required for approximately 5 years to achieve RAO No. 3 for VOCs. Monitoring for manganese is assumed to continue for 30 years. Active treatment would be completed in 2 years.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the reagents and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be no risk to the surrounding community or the environment. Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs. Approximately 20 years would be required to treat VOCs within the treatment zone and to achieve RAO Nos. 2 and 3 for VOCs. Monitoring for manganese is assumed to continue for 30 years. Active treatment would be completed in 20 years.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be no risk to the surrounding community or the environment. Groundwater RAO No. 1 would be achieved immediately upon implementation of LUCs and monitoring. In excess of 40 years would be required to meet groundwater RAO Nos. 2 and 3 through natural attenuation.
Implementability	Technical and administrative implementation would be extremely simple because there would be no action required.	Easy to implement in-situ chemical oxidation and LUCs. Less difficult to implement than Alternatives G-2A and G-3, but more difficult than Alternative G-4. Pilot-scale treatability testing would be required for injections in deep groundwater. Use of property may be temporarily affected by injection points.	Easy to implement in-situ chemical oxidation and LUCs. Less difficult to implement than Alternatives G-3, but more difficult than Alternatives G-2 and G-4. Use of property may be temporarily affected by injection points.	Easy to implement enhanced bioremediation, in-situ chemical oxidation, and LUCs. Most difficult to implement because of multiple injection events over an extended period of time. Pilot-scale treatability testing would be required for injections in deep groundwater. Use of property may be temporarily affected by injection points.	Easiest to implement because only groundwater monitoring is required. Natural attenuation and LUCs would require in excess of 40 years, requiring a long period of time.
Costs: Capital NPW of Annual Costs NPW	 $8,000 $109,000 (30 Years) $117,000 (30 Years)	 $1,615,000 $1,111,000 (30 Years) $2,727,000 (30 Years)	 $2,397,000 $875,000 (30 Years) $3,272,000 (30 Years)	 $1,164,000 $1,607,000 (30 Years) $2,771,000 (30 Years)	 $186,000 $1,111,000 (30 Years) $1,297,000 (30 Years)

ARARs - Applicable or Relevant and Appropriate Requirements.
COC - Chemicals of concern.
LUCs - Land use controls.
NA - Natural attenuation.
NPW - Net present worth.
PCBs – Polychlorinated biphenyls
PRG - Preliminary Remediation Goal.
RAO - Remedial Action Objective.
TBC – To be considered.
TCE - Trichloroethene.

REFERENCES

DoD (Department of Defense), 2003. Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and Other Post-ROD Actions. October.

FWC (Foster Wheeler Corporation), 2001. Removal Action Report for Floor Drain Removals, Hangar 2 (Building 82). April.

Navy, 2006. Navy Environmental Restoration Program Manual. August.

Stone & Webster (Stone & Webster Environmental Technology & Services), 2000. Final Summary Report of Background Data Summary Statistics for NAS South Weymouth, Weymouth, Massachusetts. February.

Stone & Webster, 2002. Final Summary Report of Background Data Summary Statistics for NAS South Weymouth, Weymouth, Massachusetts. November.

TtEC (Tetra Tech EC, Inc.), 2008. Closeout Report for Review Item Area 61, TACAN Outfall Excavation, Storm Water Drainage System Cleaning and Associated Ditch/Swale Excavation (R1). Former Naval Air Station South Weymouth, Weymouth, MA. August.

TtEC, 2011. Final Maintenance Activities Completion Report for Building 82/Hangar 2 (R1). Former Naval Air Station South Weymouth, Weymouth, MA. August.

TtNUS (Tetra Tech NUS, Inc.), 2010. Final Remedial Investigation Report for Building 82. Naval Air Station South Weymouth, Weymouth, Massachusetts. February.

TtNUS, 2011. Final Remedial Investigation Addendum for Building 82. Naval Air Station South Weymouth, Weymouth, Massachusetts. July.

USEPA (United States Environmental Protection Agency), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Interim Final). Office of Emergency Remedial Response, United States Environmental Protection Agency, Washington, DC. October.

APPENDIX A

GROUNDWATER DATA TABLES

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-A01-0912	B82-GP-A01-1720	B82-GP-A02-0912	B82-GP-A02-1720	B82-GP-A03-0912	B82-GP-A03-1720	B82-GP-B01-1214	B82-GP-B02-1013	B82-GP-B03-1013	B82-GP-B04-1013	B82-GP-B05-0912
LOCATION				B82-GP-A01	B82-GP-A01	B82-GP-A02	B82-GP-A02	B82-GP-A03	B82-GP-A03	B82-GP-B01	B82-GP-B02	B82-GP-B03	B82-GP-B04	B82-GP-B05
TOP DEPTH				9	18	9	18	10	17	12	10	10	10	9
BOTTOM DEPTH				12	20	12	20	12	20	14	13	13	13	12
SAMPLE DATE	**MCL**	**PRG**	**BKG**	07/18/06	07/19/06	07/18/06	07/19/06	07/19/06	07/20/06	07/20/06	07/21/06	07/21/06	07/25/06	07/24/06
VOLATILE ORGANIC COMPOUNDS (UG/L)														
1,1,1-TRICHLOROETHANE	200	320		***360***	7.8	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		1 U	1 U	1 U	1 U	1 U	NA	NA	NA	NA	NA	1 U
1,1-DICHLOROETHANE		81		***99 J***	1.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	7	34		14	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-TRIMETHYLBENZENE		1.2		***36***	1.2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3,5-TRIMETHYLBENZENE		1.2		***11***	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-BUTANONE		700		1 U	1 U	1 U	1 U	1 U	1 U	3	1 U	1 U	1 U	1 U
ACETONE		550		1 U	17	1 U	1 U	4.7	1 U	11	1 U	1 U	1 U	1 U
BENZENE	5	0.35		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
BTEX				16.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CHLOROETHANE		4.6		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CHLOROFORM	80	0.17	3.2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
ETHYLBENZENE	700	130		1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ISOPROPYLBENZENE		66		1.4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
METHYL TERT-BUTYL ETHER		6.2		1 U	1 U	1 U	1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SEC-BUTYLBENZENE		24		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TETRACHLOROETHENE	5	0.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOLUENE	1000	72		5.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
M+P-XYLENES		21		6.4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
O-XYLENE		21		3.1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL XYLENES		21		9.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5	0.028	0.73	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL CHLORINATED VOCS				473	9.4	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
VOLATILE GASES (UG/L)														
METHANE				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-A01-0912	B82-GP-A01-1720	B82-GP-A02-0912	B82-GP-A02-1720	B82-GP-A03-0912	B82-GP-A03-1720	B82-GP-B01-1214	B82-GP-B02-1013	B82-GP-B03-1013	B82-GP-B04-1013	B82-GP-B05-0912
LOCATION				B82-GP-A01	B82-GP-A01	B82-GP-A02	B82-GP-A02	B82-GP-A03	B82-GP-A03	B82-GP-B01	B82-GP-B02	B82-GP-B03	B82-GP-B04	B82-GP-B05
TOP DEPTH				9	18	9	18	10	17	12	10	10	10	9
BOTTOM DEPTH				12	20	12	20	12	20	14	13	13	13	12
SAMPLE DATE	**MCL**	**PRG**	**BKG**	07/18/06	07/19/06	07/18/06	07/19/06	07/19/06	07/20/06	07/20/06	07/21/06	07/21/06	07/25/06	07/24/06
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)														
2,4,6-TRICHLOROPHENOL		0.36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE		0.62		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL		180		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE		36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE		150		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORENE		24		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE		0.62		***68 J***	***3***	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
NITROBENZENE		0.34		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE		0.0096		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LOW MOLECULAR WEIGHT PAHS				68	3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
HIGH MOLECULAR WEIGHT PAHS				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL PAHS			0.0775	68	3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
PESTICIDES/PCBS (UG/L)														
AROCLOR-1260		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS (UG/L)														
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	6	1.5		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-A01-0912	B82-GP-A01-1720	B82-GP-A02-0912	B82-GP-A02-1720	B82-GP-A03-0912	B82-GP-A03-1720	B82-GP-B01-1214	B82-GP-B02-1013	B82-GP-B03-1013	B82-GP-B04-1013	B82-GP-B05-0912
LOCATION				B82-GP-A01	B82-GP-A01	B82-GP-A02	B82-GP-A02	B82-GP-A03	B82-GP-A03	B82-GP-B01	B82-GP-B02	B82-GP-B03	B82-GP-B04	B82-GP-B05
TOP DEPTH				9	18	9	18	10	17	12	10	10	10	9
BOTTOM DEPTH				12	20	12	20	12	20	14	13	13	13	12
SAMPLE DATE	**MCL**	**PRG**	**BKG**	07/18/06	07/19/06	07/18/06	07/19/06	07/19/06	07/20/06	07/20/06	07/21/06	07/21/06	07/25/06	07/24/06
METALS (UG/L) (cont.)														
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MISCELLANEOUS PARAMETERS (MG/L)														
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIELD (MG/L)														
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-B05-1720	B82-GP-C01-1013	B82-GP-C02-0912	B82-GP-C02-1720-AVG	B82-GP-C03-0912	B82-GP-C03-1922	B82-GP-C04-1013	B82-GP-D01-0710	B82-GP-D01-1720	B82-GP-D02-0811	B82-GP-D02-1720
LOCATION				B82-GP-B05	B82-GP-C01	B82-GP-C02	B82-GP-C02	B82-GP-C03	B82-GP-C03	B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02
TOP DEPTH				17	10	9	17	9	19	10	7	17	8	17
BOTTOM DEPTH				20	13	12	20	12	22	13	10	20	11	20
SAMPLE DATE	**MCL**	**PRG**	**BKG**	07/24/06	07/25/06	07/25/06	07/25/06	07/28/06	07/31/06	07/28/06	07/27/06	07/27/06	07/27/06	07/27/06
VOLATILE ORGANIC COMPOUNDS (UG/L)														
1,1,1-TRICHLOROETHANE	200	320		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		1 U	NA	NA	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHANE		81		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	7	34		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-TRIMETHYLBENZENE		1.2		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***5.4***	1 U
1,3,5-TRIMETHYLBENZENE		1.2		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***3***	1 U
2-BUTANONE		700		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ACETONE		550		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
BENZENE	5	0.35		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***1.3***	1 U
BTEX				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	4.2	1 U
CHLOROETHANE		4.6		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CHLOROFORM	80	0.17	3.2	1 U	1 UJ	1 UJ	1 U	1 UJ	1 U	1 UJ	1 U	1 U	1 U	1 U
ETHYLBENZENE	700	130		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ISOPROPYLBENZENE		66		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.4	1 U
METHYL TERT-BUTYL ETHER		6.2		1 U	1 U	1 U	1 U	1 U	***7.1***	1 U	1 U	1 U	1 U	1 U
SEC-BUTYLBENZENE		24		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.2	1 U
TETRACHLOROETHENE	5	0.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOLUENE	1000	72		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
M+P-XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.9	1 U
O-XYLENE		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2.9	1 U
TRICHLOROETHENE	5	0.028	0.73	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***1.2***	1 U	1 U
TOTAL CHLORINATED VOCS				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.2	1 U	1 U
VOLATILE GASES (UG/L)														
METHANE				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-B05-1720	B82-GP-C01-1013	B82-GP-C02-0912	B82-GP-C02-1720-AVG	B82-GP-C03-0912	B82-GP-C03-1922	B82-GP-C04-1013	B82-GP-D01-0710	B82-GP-D01-1720	B82-GP-D02-0811	B82-GP-D02-1720
LOCATION				B82-GP-B05	B82-GP-C01	B82-GP-C02	B82-GP-C02	B82-GP-C03	B82-GP-C03	B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02
TOP DEPTH				17	10	9	17	9	19	10	7	17	8	17
BOTTOM DEPTH				20	13	12	20	12	22	13	10	20	11	20
SAMPLE DATE	**MCL**	**PRG**	**BKG**	07/24/06	07/25/06	07/25/06	07/25/06	07/28/06	07/31/06	07/28/06	07/27/06	07/27/06	07/27/06	07/27/06
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)														
2,4,6-TRICHLOROPHENOL		0.36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE		0.62		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL		180		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE		36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE		150		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORENE		24		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE		0.62		1 U	***1.1***	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***3.2***	1 U
NITROBENZENE		0.34		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE		0.0096		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LOW MOLECULAR WEIGHT PAHS				1 U	1.1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.2	1 U
HIGH MOLECULAR WEIGHT PAHS				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL PAHS			0.0775	1 U	1.1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.2	1 U
PESTICIDES/PCBS (UG/L)														
AROCLOR-1260		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS (UG/L)														
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	6	1.5		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-B05-1720	B82-GP-C01-1013	B82-GP-C02-0912	B82-GP-C02-1720-AVG	B82-GP-C03-0912	B82-GP-C03-1922	B82-GP-C04-1013	B82-GP-D01-0710	B82-GP-D01-1720	B82-GP-D02-0811	B82-GP-D02-1720
LOCATION				B82-GP-B05	B82-GP-C01	B82-GP-C02	B82-GP-C02	B82-GP-C03	B82-GP-C03	B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02
TOP DEPTH				17	10	9	17	9	19	10	7	17	8	17
BOTTOM DEPTH				20	13	12	20	12	22	13	10	20	11	20
SAMPLE DATE	MCL	PRG	BKG	07/24/06	07/25/06	07/25/06	07/25/06	07/28/06	07/31/06	07/28/06	07/27/06	07/27/06	07/27/06	07/27/06
METALS (UG/L) (cont.)														
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MISCELLANEOUS PARAMETERS (MG/L)														
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIELD (MG/L)														
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-E01-0609	B82-GP-E01-1619	B82-GP-E01-1922	B82-GP-E02-0609	B82-GP-E02-1619-AVG	B82-GP-E03-0609	B82-GP-E03-1719	B82-GP-E03-1921	B82-GP-H01-12	B82-GP-H01-22	B82-GP-H02-23
LOCATION				B82-GP-E01	B82-GP-E01	B82-GP-E01	B82-GP-E02	B82-GP-E02	B82-GP-E03	B82-GP-E03	B82-GP-E03	B82-GP-H01	B82-GP-H01	B82-GP-H02
TOP DEPTH				6	16	19	6	16	6	17	19	7	17	19
BOTTOM DEPTH				9	19	22	9	19	9	19	21	12	22	23
SAMPLE DATE	**MCL**	**PRG**	**BKG**	08/01/06	08/01/06	08/01/06	08/01/06	08/01/06	08/04/06	08/04/06	08/04/06	05/12/09	05/13/09	05/13/09
VOLATILE ORGANIC COMPOUNDS (UG/L)														
1,1,1-TRICHLOROETHANE	200	320		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
1,1-DICHLOROETHANE		81		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	7	34		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-TRIMETHYLBENZENE		1.2		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
2-BUTANONE		700		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	10 U	10 U	10 U
ACETONE		550		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12	8.9 J	10 U
BENZENE	5	0.35		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 J	1 U
BTEX				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 J	0.4 J	1 U
CHLOROETHANE		4.6		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
CHLOROFORM	80	0.17	3.2	1 U	1 U	1 U	1 U	1 U	1 U	***4.6***	***1.4***	1 U	1 U	1 U
ETHYLBENZENE	700	130		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ISOPROPYLBENZENE		66		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
METHYL TERT-BUTYL ETHER		6.2		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
SEC-BUTYLBENZENE		24		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
TETRACHLOROETHENE	5	0.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOLUENE	1000	72		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 J	0.2 J	1 U
M+P-XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
O-XYLENE		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5	0.028	0.73	1 U	1 U	1 U	1 U	1 U	1 U	***1.8***	***2.7***	1 U	***1.7***	***2.8***
TOTAL CHLORINATED VOCS				1 U	1 U	1 U	1 U	1 U	1 U	6.4	4.1	1 U	1.7	2.8
VOLATILE GASES (UG/L)														
METHANE				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-E01-0609	B82-GP-E01-1619	B82-GP-E01-1922	B82-GP-E02-0609	B82-GP-E02-1619-AVG	B82-GP-E03-0609	B82-GP-E03-1719	B82-GP-E03-1921	B82-GP-H01-12	B82-GP-H01-22	B82-GP-H02-23
LOCATION				B82-GP-E01	B82-GP-E01	B82-GP-E01	B82-GP-E02	B82-GP-E02	B82-GP-E03	B82-GP-E03	B82-GP-E03	B82-GP-H01	B82-GP-H01	B82-GP-H02
TOP DEPTH				6	16	19	6	16	6	17	19	7	17	19
BOTTOM DEPTH				9	19	22	9	19	9	19	21	12	22	23
SAMPLE DATE	**MCL**	**PRG**	**BKG**	08/01/06	08/01/06	08/01/06	08/01/06	08/01/06	08/04/06	08/04/06	08/04/06	05/12/09	05/13/09	05/13/09
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)														
2,4,6-TRICHLOROPHENOL		0.36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE		0.62		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL		180		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE		36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE		150		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FLUORENE		24		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE		0.62		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
NITROBENZENE		0.34		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE		0.0096		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LOW MOLECULAR WEIGHT PAHS				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
HIGH MOLECULAR WEIGHT PAHS				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL PAHS			0.0775	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA
PESTICIDES/PCBS (UG/L)														
AROCLOR-1260		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS (UG/L)														
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	6	1.5		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-E01-0609	B82-GP-E01-1619	B82-GP-E01-1922	B82-GP-E02-0609	B82-GP-E02-1619-AVG	B82-GP-E03-0609	B82-GP-E03-1719	B82-GP-E03-1921	B82-GP-H01-12	B82-GP-H01-22	B82-GP-H02-23
LOCATION				B82-GP-E01	B82-GP-E01	B82-GP-E01	B82-GP-E02	B82-GP-E02	B82-GP-E03	B82-GP-E03	B82-GP-E03	B82-GP-H01	B82-GP-H01	B82-GP-H02
TOP DEPTH				6	16	19	6	16	6	17	19	7	17	19
BOTTOM DEPTH				9	19	22	9	19	9	19	21	12	22	23
SAMPLE DATE	MCL	PRG	BKG	08/01/06	08/01/06	08/01/06	08/01/06	08/01/06	08/04/06	08/04/06	08/04/06	05/12/09	05/13/09	05/13/09
METALS (UG/L) (cont.)														
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MISCELLANEOUS PARAMETERS (MG/L)														
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIELD (MG/L)														
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-H02-13-AVG	B82-GP-H03-10	B82-GP-H03-19	B82-GP-H04-20	B82-GP-H04-10-AVG	B82-GP-H05-09	B82-GP-H05-14	B82-GP-H05-18	B82-GW-MW01-1006	B82-GW-MW02-1106
LOCATION				B82-GP-H02	B82-GP-H03	B82-GP-H03	B82-GP-H04	B82-GP-H04	B82-GP-H05	B82-GP-H05	B82-GP-H05	B82-MW-01	B82-MW-02
TOP DEPTH				9	6	15	16	6	5	10	14		
BOTTOM DEPTH				13	10	19	20	10	9	14	18		
SAMPLE DATE	MCL	PRG	BKG	05/13/09	05/14/09	05/14/09	05/15/09	05/15/09	05/18/09	05/18/09	05/18/09	10/30/06	11/02/06
VOLATILE ORGANIC COMPOUNDS (UG/L)													
1,1,1-TRICHLOROETHANE	200	320		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		NA	NA	NA	NA	NA	NA	NA	NA	0.66	0.5 U
1,1-DICHLOROETHANE		81		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	18	1.8
1,1-DICHLOROETHENE	7	34		NA	NA	NA	NA	NA	NA	NA	NA	1.6	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
1,2,4-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE		700		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	5 UJ	5 U
ACETONE		550		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	5 UJ	5 UJ
BENZENE	5	0.35		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.1 U	0.1 U
BTEX				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.1 U	0.1 U
CHLOROETHANE		4.6		NA	NA	NA	NA	NA	NA	NA	NA	2.6	0.5 U
CHLOROFORM	80	0.17	3.2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.1 U	0.1 U
ETHYLBENZENE	700	130		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
ISOPROPYLBENZENE		66		NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.5 U
METHYL TERT-BUTYL ETHER		6.2		NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.35 J
SEC-BUTYLBENZENE		24		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	5	0.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.1 U	0.1 U
TOLUENE	1000	72		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
M+P-XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA
O-XYLENE		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA
TOTAL XYLENES		21		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	0.73	***1.05***	***0.7 J***	***1.3***	***8.5***	1 U	1 U	1 U	1 U	0.1 U	0.1 U
TOTAL CHLORINATED VOCS				1.05	0.7 J	1.3	8.5	1 U	1 U	1 U	1 U	22.2	1.8
VOLATILE GASES (UG/L)													
METHANE				NA	NA	NA	NA	NA	NA	NA	NA	220	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-H02-13-AVG	B82-GP-H03-10	B82-GP-H03-19	B82-GP-H04-20	B82-GP-H04-10-AVG	B82-GP-H05-09	B82-GP-H05-14	B82-GP-H05-18	B82-GW-MW01-1006	B82-GW-MW02-1106
LOCATION				B82-GP-H02	B82-GP-H03	B82-GP-H03	B82-GP-H04	B82-GP-H04	B82-GP-H05	B82-GP-H05	B82-GP-H05	B82-MW-01	B82-MW-02
TOP DEPTH				9	6	15	16	6	5	10	14		
BOTTOM DEPTH				13	10	19	20	10	9	14	18		
SAMPLE DATE	MCL	PRG	BKG	05/13/09	05/14/09	05/14/09	05/15/09	05/15/09	05/18/09	05/18/09	05/18/09	10/30/06	11/02/06
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)													
2,4,6-TRICHLOROPHENOL		0.36		NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.1 U
2-METHYLNAPHTHALENE		0.62		NA	NA	NA	NA	NA	NA	NA	NA	***1.4***	0.1 U
2-METHYLPHENOL		180		NA	NA	NA	NA	NA	NA	NA	NA	0.1	0.1 UJ
ACENAPHTHENE		36		NA	NA	NA	NA	NA	NA	NA	NA	0.13	0.1 U
FLUORANTHENE		150		NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.1 U
FLUORENE		24		NA	NA	NA	NA	NA	NA	NA	NA	0.13	0.1 U
NAPHTHALENE		0.62		NA	NA	NA	NA	NA	NA	NA	NA	***2.2***	0.1 U
NITROBENZENE		0.34		NA	NA	NA	NA	NA	NA	NA	NA	***3***	0.1 U
N-NITROSO-DI-N-PROPYLAMINE		0.0096		NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.1 U
LOW MOLECULAR WEIGHT PAHS				NA	NA	NA	NA	NA	NA	NA	NA	3.86	0.1 U
HIGH MOLECULAR WEIGHT PAHS				NA	NA	NA	NA	NA	NA	NA	NA	0.1 U	0.1 U
TOTAL PAHS			0.0775	NA	NA	NA	NA	NA	NA	NA	NA	3.86	0.1 U
PESTICIDES/PCBS (UG/L)													
AROCLOR-1260		0.034		NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U
METALS (UG/L)													
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	32 U	32 U
ANTIMONY	6	1.5		NA	NA	NA	NA	NA	NA	NA	NA	0.056 UJ	0.406 UJ
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	***0.351 J***	***4.24***
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	9.13 J	19.5 J
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	0.043 U	0.043 U
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	0.094 U	0.094 U
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	32800 J	22500
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	0.253 UJ	0.919 UJ
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	0.52 U	0.52 U
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	***1730 J***	***5640***
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	0.075 UJ	0.075 U
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	5200 J	6870
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	***159***	***995***
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	0.0794 UJ	0.018 UJ
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	1.1 UJ	0.972 UJ

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-H02-13-AVG	B82-GP-H03-10	B82-GP-H03-19	B82-GP-H04-20	B82-GP-H04-10-AVG	B82-GP-H05-09	B82-GP-H05-14	B82-GP-H05-18	B82-GW-MW01-1006	B82-GW-MW02-1106
LOCATION				B82-GP-H02	B82-GP-H03	B82-GP-H03	B82-GP-H04	B82-GP-H04	B82-GP-H05	B82-GP-H05	B82-GP-H05	B82-MW-01	B82-MW-02
TOP DEPTH				9	6	15	16	6	5	10	14		
BOTTOM DEPTH				13	10	19	20	10	9	14	18		
SAMPLE DATE	MCL	PRG	BKG	05/13/09	05/14/09	05/14/09	05/15/09	05/15/09	05/18/09	05/18/09	05/18/09	10/30/06	11/02/06
METALS (UG/L) (cont.)													
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	3240	2210
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	14000 J	14200
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	0.335 UJ	0.204 UJ
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	1.8 UJ	3.49 UJ
MISCELLANEOUS PARAMETERS (MG/L)													
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	0.2 U	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	13	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	0.13 U	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	27	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	2.4	NA
FIELD (MG/L)													
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW03-1006	B82-GW-MW07S-1006	B82-GW-MW08-015-1006	B82-GW-MW08-016-1006-AVG	B82-GW-MW09S-1006	B82-GW-MW10S-1006	B82-GW-MW11S-1006	B82-GW-MW200S-1006
LOCATION				B82-MW-03	B82-MW-07S	B82-MW08-015	B82-MW08-016	B82-MW-09S	B82-MW-10S	B82-MW-11S	B82-MW-200S
TOP DEPTH											
BOTTOM DEPTH											
SAMPLE DATE	MCL	PRG	BKG	10/30/06	10/26/06	10/27/06	10/30/06	10/30/06	10/31/06	10/26/06	10/26/06
VOLATILE ORGANIC COMPOUNDS (UG/L)											
1,1,1-TRICHLOROETHANE	200	320		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE		81		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	7	34		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.3	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.3	0.5 U
1,2,4-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE		700		5 U	5 U	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 U
ACETONE		550		5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
BENZENE	5	0.35		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.13	0.1 U
BTEX				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.13	0.1 U
CHLOROETHANE		4.6		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	80	0.17	3.2	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
ETHYLBENZENE	700	130		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
ISOPROPYLBENZENE		66		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
METHYL TERT-BUTYL ETHER		6.2		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.3
SEC-BUTYLBENZENE		24		NA	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	5	0.1		***0.14***	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TOLUENE	1000	72		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
M+P-XYLENES		21		NA	NA	NA	NA	NA	NA	NA	NA
O-XYLENE		21		NA	NA	NA	NA	NA	NA	NA	NA
TOTAL XYLENES		21		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	0.73	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	***0.11***	0.1 U	0.1 U
TOTAL CHLORINATED VOCS				0.14	0.1 U	0.1 U	0.1 U	0.1 U	0.11	1.3	0.1 U
VOLATILE GASES (UG/L)											
METHANE				NA	NA	NA	14 U	NA	NA	930	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW03-1006	B82-GW-MW07S-1006	B82-GW-MW08-015-1006	B82-GW-MW08-016-1006-AVG	B82-GW-MW09S-1006	B82-GW-MW10S-1006	B82-GW-MW11S-1006	B82-GW-MW200S-1006
LOCATION				B82-MW-03	B82-MW-07S	B82-MW08-015	B82-MW08-016	B82-MW-09S	B82-MW-10S	B82-MW-11S	B82-MW-200S
TOP DEPTH											
BOTTOM DEPTH											
SAMPLE DATE	**MCL**	**PRG**	**BKG**	10/30/06	10/26/06	10/27/06	10/30/06	10/30/06	10/31/06	10/26/06	10/26/06
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)											
2,4,6-TRICHLOROPHENOL		0.36		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
2-METHYLNAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
2-METHYLPHENOL		180		0.1 UJ	0.1 UJ	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U	0.1 U
ACENAPHTHENE		36		0.1 U	0.1 U	0.1 U	0.075	0.1 U	0.1 U	0.1 U	0.1 U
FLUORANTHENE		150		0.1 U	0.1 U	0.1 U	0.12	0.1 U	0.1 U	0.1 U	0.1 U
FLUORENE		24		0.1 U	0.1 U	0.1 U	0.125	0.1 U	0.1 U	0.1 U	0.1 U
NAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U	0.365	0.1 U	0.1 U	0.38	0.1 U
NITROBENZENE		0.34		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
N-NITROSO-DI-N-PROPYLAMINE		0.0096		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	***0.29***
LOW MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U	0.565	0.1 U	0.1 U	0.38	0.1 U
HIGH MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U	0.12	0.1 U	0.1 U	0.1 U	0.1 U
TOTAL PAHS			0.0775	0.1 U	0.1 U	0.1 U	0.685	0.1 U	0.1 U	0.38	0.1 U
PESTICIDES/PCBS (UG/L)											
AROCLOR-1260		0.034		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL AROCLOR	0.5	0.034		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
METALS (UG/L)											
ALUMINUM		3600	15341.35	32 U	498 J	32 U	33.6 J	72.2 J	182	130 J	39.3 J
ANTIMONY	6	1.5		0.056 UJ	0.056 UJ	0.056 UJ	0.12 UJ	0.056 UJ	0.493 J	0.056 UJ	0.056 UJ
ARSENIC	10	0.045		***0.198 J***	***0.335 J***	***4.57***	***5.32***	***0.238 J***	***0.114 J***	***1.62***	***0.447 J***
BARIUM	2000	260	181.32	12 J	15.4 J	32.3 J	32.2 J	10.9 J	16.3 J	30.8 J	6.36 J
BERYLLIUM	4	7.3	0.77	0.068 J	0.0481 J	0.043 U	0.345 J	0.181 J	0.043 U	0.26 J	0.043 U
CADMIUM	5	1.8		0.0997 J	0.113 J	0.094 U	0.261 J	0.153 J	0.094 U	0.105 J	0.094 U
CALCIUM			19187.09	10400 J	16600 J	12300 J	8070 J	10300 J	14100	7700 J	29000 J
COBALT		73	8.5	0.509 UJ	0.638 UJ	3.15 J	1.3 UJ	2.15 J	0.213 UJ	0.491 UJ	0.784 UJ
COPPER	1300	150	13.5	1.03 J	3.38 J	0.52 U	0.882 J	0.925 J	0.526 UJ	1.31 J	0.614 J
IRON		1100	44137.52	910 J	797 J	***29400 J***	***9480 J***	207 J	246	***21700 J***	131 J
LEAD	15			0.116 J	0.674 J	0.075 UJ	0.135 J	0.189 J	0.164 J	0.763 J	0.075 UJ
MAGNESIUM			14205.47	2870 J	7330 J	2720 J	924 J	669 J	790	1740 J	13500 J
MANGANESE		88	2680.63	13.6 J	76.4	***5600***	***620***	44.5	3.62 J	***1270***	***6020***
MERCURY	2	1.1		0.0317 UJ	0.0232 UJ	0.0548 UJ	0.0652 UJ	0.0528 UJ	0.0825 J	0.0566 UJ	0.0407 UJ
NICKEL		73		0.827 UJ	2.29 J	0.889 UJ	1.58 J	2.13 J	0.955 J	0.748 UJ	1.74 UJ

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW03-1006	B82-GW-MW07S-1006	B82-GW-MW08-015-1006	B82-GW-MW08-016-1006-AVG	B82-GW-MW09S-1006	B82-GW-MW10S-1006	B82-GW-MW11S-1006	B82-GW-MW200S-1006
LOCATION				B82-MW-03	B82-MW-07S	B82-MW08-015	B82-MW08-016	B82-MW-09S	B82-MW-10S	B82-MW-11S	B82-MW-200S
TOP DEPTH											
BOTTOM DEPTH											
SAMPLE DATE	**MCL**	**PRG**	**BKG**	10/30/06	10/26/06	10/27/06	10/30/06	10/30/06	10/31/06	10/26/06	10/26/06
METALS (UG/L) (cont.)											
POTASSIUM			6177.62	1500	2030	2690	3520	1570	2870	1530	2930
SODIUM			47342.14	13100 J	24200 J	5880 J	4100 J	3770 J	5870	3960 J	12500 J
VANADIUM		3.6	22.6	0.933 J	1.38 J	0.806 J	2.91 J	0.791 J	1.84 J	***9.35 J***	0.787 J
ZINC		1100	51.7	4.88 J	4.31 J	4.74 J	7.16 J	3.59 J	2.46 UJ	4.48 J	3.29 J
MISCELLANEOUS PARAMETERS (MG/L)											
AMMONIA-N				NA	NA	NA	0.4	NA	NA	1.7	NA
CHLORIDE	250			NA	NA	NA	3.7	NA	NA	4	NA
NITRATE	10	1		NA	NA	NA	0.14	NA	NA	0.13 U	NA
SULFATE	250			NA	NA	NA	9.8	NA	NA	6.8	NA
TOTAL ORGANIC CARBON				NA	NA	NA	2.4	NA	NA	7.1	NA
FIELD (MG/L)											
FERROUS IRON				NA	NA	NA	9.15	NA	NA	3.21	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW201S-1006	B82-GW-MW202S-1006	B82-GW-MW203S-1106	B82-GW-MW204S-1106
LOCATION				B82-MW-201S	B82-MW-202S	B82-MW-203S	B82-MW-204S
TOP DEPTH							
BOTTOM DEPTH							
SAMPLE DATE	MCL	PRG	BKG	10/25/06	10/31/06	11/02/06	11/02/06
VOLATILE ORGANIC COMPOUNDS (UG/L)							
1,1,1-TRICHLOROETHANE	200	320		0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE		81		0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	7	34		0.5 U	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		0.5 U	0.5 U	0.5 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2		NA	NA	NA	NA
2-BUTANONE		700		5 U	5 U	5 U	5 U
ACETONE		550		5 UJ	5 UJ	5 UJ	5 UJ
BENZENE	5	0.35		0.1 U	0.1 U	0.1 U	0.1 U
BTEX				0.1 U	0.1 U	0.1 U	0.1 U
CHLOROETHANE		4.6		0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	80	0.17	3.2	0.1 U	0.1 U	0.1 U	0.1 U
ETHYLBENZENE	700	130		0.5 U	0.5 U	0.5 U	0.5 U
ISOPROPYLBENZENE		66		0.5 U	0.5 U	0.5 U	0.5 U
METHYL TERT-BUTYL ETHER		6.2		0.5 U	0.5 U	0.5 U	0.5 U
SEC-BUTYLBENZENE		24		NA	NA	NA	NA
TETRACHLOROETHENE	5	0.1		0.1 U	0.1 U	***0.4***	0.1 U
TOLUENE	1000	72		0.5 U	0.5 U	0.5 U	0.5 U
M+P-XYLENES		21		NA	NA	NA	NA
O-XYLENE		21		NA	NA	NA	NA
TOTAL XYLENES		21		0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	0.73	0.1 U	***0.94***	0.1 U	0.1 U
TOTAL CHLORINATED VOCS				0.1 U	0.94	0.4	0.1 U
VOLATILE GASES (UG/L)							
METHANE				14 U	NA	NA	NA

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW201S-1006	B82-GW-MW202S-1006	B82-GW-MW203S-1106	B82-GW-MW204S-1106
LOCATION				B82-MW-201S	B82-MW-202S	B82-MW-203S	B82-MW-204S
TOP DEPTH							
BOTTOM DEPTH							
SAMPLE DATE	**MCL**	**PRG**	**BKG**	10/25/06	10/31/06	11/02/06	11/02/06
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)							
2,4,6-TRICHLOROPHENOL		0.36		0.11	0.1 U	0.1 U	0.1 U
2-METHYLNAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U	0.1 U
2-METHYLPHENOL		180		0.1 UJ	0.1 UJ	0.1 UJ	0.1 UJ
ACENAPHTHENE		36		0.1 U	0.1 U	0.1 U	0.1 U
FLUORANTHENE		150		0.1 U	0.1 U	0.1 U	0.1 U
FLUORENE		24		0.1 U	0.1 U	0.1 U	0.1 U
NAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U	0.1 U
NITROBENZENE		0.34		0.1 U	0.1 U	0.1 U	0.1 U
N-NITROSO-DI-N-PROPYLAMINE		0.0096		0.1 U	0.1 U	0.1 U	0.1 U
LOW MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U	0.1 U
HIGH MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U	0.1 U
TOTAL PAHS			0.0775	0.1 U	0.1 U	0.1 U	0.1 U
PESTICIDES/PCBS (UG/L)							
AROCLOR-1260		0.034		0.2 U	0.2 U	0.028 J	0.2 U
TOTAL AROCLOR	0.5	0.034		0.2 U	0.2 U	0.028	0.2 U
METALS (UG/L)							
ALUMINUM		3600	15341.35	386 J	732	435	32 U
ANTIMONY	6	1.5		0.056 UJ	0.056 U	0.184 UJ	0.056 U
ARSENIC	10	0.045		***0.124 J***	***3.46***	***0.275 J***	***0.272 J***
BARIUM	2000	260	181.32	10.5 J	20 J	23.6 J	9.8 J
BERYLLIUM	4	7.3	0.77	0.043 U	0.0585 J	0.043 U	0.043 U
CADMIUM	5	1.8		0.094 U	0.107 J	0.094 U	0.094 U
CALCIUM			19187.09	12000 J	9740	18800	21800
COBALT		73	8.5	0.761 UJ	1.57 UJ	0.375 UJ	0.534 UJ
COPPER	1300	150	13.5	0.869 J	1.31 UJ	1.11 UJ	0.535 UJ
IRON		1100	44137.52	577 J	***10400***	681	1060
LEAD	15			0.258 J	0.715 J	0.848 J	0.118 J
MAGNESIUM			14205.47	4370 J	3580	2070	6350
MANGANESE		88	2680.63	***113***	***379***	***114***	***351***
MERCURY	2	1.1		0.0202 UJ	0.018 UJ	0.0855 J	0.018 UJ
NICKEL		73		1.59 J	1.92 J	1.35 J	1.31 J

TABLE 4-8

SUMMARY OF ANALYTICAL DATA[1] - SHALLOW GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW201S-1006	B82-GW-MW202S-1006	B82-GW-MW203S-1106	B82-GW-MW204S-1106
LOCATION				B82-MW-201S	B82-MW-202S	B82-MW-203S	B82-MW-204S
TOP DEPTH							
BOTTOM DEPTH							
SAMPLE DATE	**MCL**	**PRG**	**BKG**	10/25/06	10/31/06	11/02/06	11/02/06
METALS (UG/L) (cont.)							
POTASSIUM			6177.62	1650	1710	4850	2350
SODIUM			47342.14	13500 J	13000	13700	13000
VANADIUM		3.6	22.6	0.946 J	1.96 J	1.35 J	0.476 J
ZINC		1100	51.7	3.28 J	5.47 UJ	3.52 UJ	3.88 UJ
MISCELLANEOUS PARAMETERS (MG/L)							
AMMONIA-N				0.2 U	NA	NA	NA
CHLORIDE	250			6.7	NA	NA	NA
NITRATE	10	1		***2.2***	NA	NA	NA
SULFATE	250			12	NA	NA	NA
TOTAL ORGANIC CARBON				1 U	NA	NA	NA
FIELD (MG/L)							
FERROUS IRON				0.03 UJ	NA	NA	NA

Notes:

1) This table contains the detect and non-detect results for all parameters detected in at least one sample in this media subgroup.
Complete results for all parameters are presented in Appendix F.

PRG - EPA Region IX PRGs for tap water (EPA. 2004) (human health risk based values). The PRG values presented represent a cancer risk level of 10-6 and a hazard quotient of 0.1.

MCL - The lower of the U.S. EPA Maximum Contaminant Level (MCL) for drinking water and the Massachusetts MCL (MMCL).

BKG - NAS South Weymouth Background Value (Stone & Webster, 2002)

Black Background/White print - Primary Criteria Exceeded

Bold Italics (black or gray background) - Secondary Criteria Exceeded

Gray Background - Detected

B or JB - Possible Field Blank Contamination

U - Not Detected

UJ - Detection Limit Approximate

J - Quantitation Limit Approximate

R - Rejected

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
PAGE 1 OF 10

SAMPLE ID	MCL	PRG	BKG	B82-GP-A01-2629	B82-GP-A02-2427-AVG	B82-GP-A03-2629	B82-GP-A03-3538	B82-GP-B01-2023-AVG	B82-GP-B01-2528	B82-GP-B02-2023	B82-GP-B02-2528	B82-GP-B03-2023	B82-GP-B03-3033	B82-GP-B03-4043-AVG
LOCATION				B82-GP-A01	B82-GP-A02	B82-GP-A03	B82-GP-A03	B82-GP-B01	B82-GP-B01	B82-GP-B02	B82-GP-B02	B82-GP-B03	B82-GP-B03	B82-GP-B03
TOP DEPTH				26	25	26	35	20	25	20	25	20	30	40
BOTTOM DEPTH				29	27	29	38	23	28	23	28	23	33	43
SAMPLE DATE				07/19/06	07/19/06	07/20/06	07/20/06	07/20/06	07/20/06	07/21/06	07/21/06	07/21/06	07/24/06	07/24/06
VOLATILE ORGANIC COMPOUNDS (UG/L)														
1,1,1-TRICHLOROETHANE	200	320		2.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		1 U	1 U	1 U	NA	NA	NA	NA	NA	NA	1 U	1 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ACETONE		550		1 U	1 U	7.6	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CARBON DISULFIDE		100		1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
DICHLORODIFLUOROMETHANE		39		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
METHYL TERT-BUTYL ETHER		6.2		1.1	3.7	1 U	2.5	***6.3 J***	5.3 J	1 U	2	1.9	1 U	1 U
TRICHLOROETHENE	5	0.028	0.73	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL CHLORINATED VOCS				2.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)														
NAPHTHALENE		0.62		***2.1***	1 U	1 U	1 U	***0.85***	1 U	1 U	1 U	1 U	1 U	1 U
LOW MOLECULAR WEIGHT PAHS				2.1	1 U	1 U	1 U	0.85	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL PAHS			0.0775	2.1	1 U	1 U	1 U	0.85	1 U	1 U	1 U	1 U	1 U	1 U
PESTICIDES/PCBS (UG/L)														
ALPHA-CHLORDANE	2	0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DIELDRIN		0.0042		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	2	0.015		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	0.2	0.0074		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS (UG/L)														
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	100	11	18.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
PAGE 2 OF 10

SAMPLE ID				B82-GP-A01-2629	B82-GP-A02-2427-AVG	B82-GP-A03-2629	B82-GP-A03-3538	B82-GP-B01-2023-AVG	B82-GP-B01-2528	B82-GP-B02-2023	B82-GP-B02-2528	B82-GP-B03-2023	B82-GP-B03-3033	B82-GP-B03-4043-AVG
LOCATION				B82-GP-A01	B82-GP-A02	B82-GP-A03	B82-GP-A03	B82-GP-B01	B82-GP-B01	B82-GP-B02	B82-GP-B02	B82-GP-B03	B82-GP-B03	B82-GP-B03
TOP DEPTH				26	25	26	35	20	25	20	25	20	30	40
BOTTOM DEPTH				29	27	29	38	23	28	23	28	23	33	43
SAMPLE DATE	MCL	PRG	BKG	07/19/06	07/19/06	07/20/06	07/20/06	07/20/06	07/20/06	07/21/06	07/21/06	07/21/06	07/24/06	07/24/06
METALS (UG/L) (cont.)														
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SILVER		18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MISCELLANEOUS PARAMETERS (MG/L)														
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIELD (MG/L)														
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-B03-4447	B82-GP-B04-2023	B82-GP-B04-3033	B82-GP-B04-4042	B82-GP-B05-2528	B82-GP-C01-2023	B82-GP-C01-2932	B82-GP-C02-2730	B82-GP-C02-3740	B82-GP-C03-2629	B82-GP-C04-2023
LOCATION				B82-GP-B03	B82-GP-B04	B82-GP-B04	B82-GP-B04	B82-GP-B05	B82-GP-C01	B82-GP-C01	B82-GP-C02	B82-GP-C02	B82-GP-C03	B82-GP-C04
TOP DEPTH				44	20	30	40	25	20	29	27	37	26	20
BOTTOM DEPTH				47	23	33	42	28	23	32	30	40	29	23
SAMPLE DATE	MCL	PRG	BKG	07/24/06	07/25/06	07/25/06	07/26/06	07/24/06	07/25/06	07/25/06	07/26/06	07/26/06	07/31/06	07/31/06
VOLATILE ORGANIC COMPOUNDS (UG/L)														
1,1,1-TRICHLOROETHANE	200	320		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		NA	NA	1 U	1 U	1 U	NA	NA	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1
ACETONE		550		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	7.8 U	1 U
CARBON DISULFIDE		100		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
DICHLORODIFLUOROMETHANE		39		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
METHYL TERT-BUTYL ETHER		6.2		1 U	1 U	1 U	1 U	1 U	1.4	1 U	1.8 J	1 U	1 U	1 U
TRICHLOROETHENE	5	0.028	0.73	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	***3.7 J***
TOTAL CHLORINATED VOCS				1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	4.7
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)														
NAPHTHALENE		0.62		1 U	1 U	1 U	1 U	0.57 J	1 U	1 U	1 U	1 U	1 U	1 U
LOW MOLECULAR WEIGHT PAHS				1 U	1 U	1 U	1 U	0.57	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL PAHS			0.0775	1 U	1 U	1 U	1 U	0.57	1 U	1 U	1 U	1 U	1 U	1 U
PESTICIDES/PCBS (UG/L)														
ALPHA-CHLORDANE	2	0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
DIELDRIN		0.0042		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	2	0.015		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	0.2	0.0074		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
METALS (UG/L)														
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	100	11	18.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-B03-4447	B82-GP-B04-2023	B82-GP-B04-3033	B82-GP-B04-4042	B82-GP-B05-2528	B82-GP-C01-2023	B82-GP-C01-2932	B82-GP-C02-2730	B82-GP-C02-3740	B82-GP-C03-2629	B82-GP-C04-2023
LOCATION				B82-GP-B03	B82-GP-B04	B82-GP-B04	B82-GP-B04	B82-GP-B05	B82-GP-C01	B82-GP-C01	B82-GP-C02	B82-GP-C02	B82-GP-C03	B82-GP-C04
TOP DEPTH				44	20	30	40	25	20	29	27	37	26	20
BOTTOM DEPTH				47	23	33	42	28	23	32	30	40	29	23
SAMPLE DATE	MCL	PRG	BKG	07/24/06	07/25/06	07/25/06	07/26/06	07/24/06	07/25/06	07/25/06	07/26/06	07/26/06	07/31/06	07/31/06
METALS (UG/L) (cont.)														
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SILVER		18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MISCELLANEOUS PARAMETERS (MG/L)														
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FIELD (MG/L)														
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GP-C04-3235-AVG	B82-GP-D01-2730	B82-GP-D01-3538	B82-GP-D02-2730	B82-GP-D02-3740	B82-GP-D02-4346	B82-GP-H01-30	B82-GP-H03-28	B82-GP-H04-30	B82-GW-MW01D-1106
LOCATION				B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02	B82-GP-D02	B82-GP-H01	B82-GP-H03	B82-GP-H04	B82-MW-01D
TOP DEPTH				32	27	35	27	37	43	26	24	26	
BOTTOM DEPTH				35	30	38	30	40	46	30	28	30	
SAMPLE DATE	MCL	PRG	BKG	07/31/06	07/27/06	07/28/06	07/27/06	07/28/06	07/28/06	05/14/09	05/14/09	05/15/09	11/01/06
VOLATILE ORGANIC COMPOUNDS (UG/L)													
1,1,1-TRICHLOROETHANE	200	320		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 U
ACETONE		550		1 U	1 U	1 U	1 U	1 U	4.6	10 U	10 U	10 U	5 UJ
CARBON DISULFIDE		100		1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	0.5 U
DICHLORODIFLUOROMETHANE		39		5 U	5 U	5 U	5 U	5 U	5 U	NA	NA	NA	0.5 U
METHYL TERT-BUTYL ETHER		6.2		1 U	1 U	1 U	1 U	1.2	1 U	NA	NA	NA	0.5 U
TRICHLOROETHENE	5	0.028	0.73	1 U	***1.7***	1 U	1 U	1 U	1 U	***5.9***	***6.5***	***2.5***	0.1 U
TOTAL CHLORINATED VOCS				1 U	1.7	1 U	1 U	1 U	1 U	5.9	6.5	2.5	0.1 U
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)													
NAPHTHALENE		0.62		1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	0.1 U
LOW MOLECULAR WEIGHT PAHS				1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	0.1 U
TOTAL PAHS			0.0775	1 U	1 U	1 U	1 U	1 U	1 U	NA	NA	NA	0.1 U
PESTICIDES/PCBS (UG/L)													
ALPHA-CHLORDANE	2	0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.098 J
DIELDRIN		0.0042		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.004 U
GAMMA-CHLORDANE	2	0.015		NA	NA	NA	NA	NA	NA	NA	NA	NA	***0.073***
HEPTACHLOR EPOXIDE	0.2	0.0074		NA	NA	NA	NA	NA	NA	NA	NA	NA	***0.012 J***
AROCLOR-1248		0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.91 UJ
TOTAL AROCLOR	0.5	0.034		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U
METALS (UG/L)													
ALUMINUM		3600	15341.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	32 U
ARSENIC	10	0.045		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.1 U
BARIUM	2000	260	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.27 J
BERYLLIUM	4	7.3	0.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.043 U
CADMIUM	5	1.8		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.094 U
CALCIUM			19187.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	13100
CHROMIUM	100	11	18.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.624 UJ
COBALT		73	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.362 UJ
COPPER	1300	150	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.55 U

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
PAGE 6 OF 10

SAMPLE ID				B82-GP-C04-3235-AVG	B82-GP-D01-2730	B82-GP-D01-3538	B82-GP-D02-2730	B82-GP-D02-3740	B82-GP-D02-4346	B82-GP-H01-30	B82-GP-H03-28	B82-GP-H04-30	B82-GW-MW01D-1106
LOCATION				B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02	B82-GP-D02	B82-GP-H01	B82-GP-H03	B82-GP-H04	B82-MW-01D
TOP DEPTH				32	27	35	27	37	43	26	24	26	
BOTTOM DEPTH				35	30	38	30	40	46	30	28	30	
SAMPLE DATE	MCL	PRG	BKG	07/31/06	07/27/06	07/28/06	07/27/06	07/28/06	07/28/06	05/14/09	05/14/09	05/15/09	11/01/06
METALS (UG/L) (cont.)													
IRON		1100	44137.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	44.2 J
LEAD	15			NA	NA	NA	NA	NA	NA	NA	NA	NA	0.075 U
MAGNESIUM			14205.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	5690
MANGANESE		88	2680.63	NA	NA	NA	NA	NA	NA	NA	NA	NA	26.5
MERCURY	2	1.1		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.018 UJ
NICKEL		73		NA	NA	NA	NA	NA	NA	NA	NA	NA	2.46 J
POTASSIUM			6177.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	784
SILVER		18		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0922 J
SODIUM			47342.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	16000
VANADIUM		3.6	22.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.262 UJ
ZINC		1100	51.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.87 UJ
MISCELLANEOUS PARAMETERS (MG/L)													
AMMONIA-N				NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2 U
CHLORIDE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	13
NITRATE	10	1		NA	NA	NA	NA	NA	NA	NA	NA	NA	0.46
SULFATE	250			NA	NA	NA	NA	NA	NA	NA	NA	NA	15
TOTAL ORGANIC CARBON				NA	NA	NA	NA	NA	NA	NA	NA	NA	1 U
FIELD (MG/L)													
FERROUS IRON				NA	NA	NA	NA	NA	NA	NA	NA	NA	0.08

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW03D-1106	B82-GW-MW07D-1006	B82-GW-MW08-016D-1006-AVG	B82-GW-MW09D-1006	B82-GW-MW10D-1006	B82-GW-MW11D-1006	B82-GW-MW200D-1006	B82-GW-MW201D-1006
LOCATION				B82-MW-03D	B82-MW-07D	B82-MW08-016D	B82-MW-09D	B82-MW-10D	B82-MW-11D	B82-MW-200D	B82-MW-201D
TOP DEPTH											
BOTTOM DEPTH											
SAMPLE DATE	MCL	PRG	BKG	11/01/06	10/25/06	10/26/06	10/27/06	10/27/06	10/30/06	10/26/06	10/25/06
VOLATILE ORGANIC COMPOUNDS (UG/L)											
1,1,1-TRICHLOROETHANE	200	320		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		0.5 U	0.5 UJ	0.5 U	0.5 U	0.35 J	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		0.5 U	0.5 U	0.5 U	0.5 U	0.43 J	0.5 U	0.5 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		0.5 U	0.5 U	0.5 U	0.5 U	0.43	0.5 U	0.5 U	0.5 U
ACETONE		550		5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
CARBON DISULFIDE		100		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
DICHLORODIFLUOROMETHANE		39		2.7	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ
METHYL TERT-BUTYL ETHER		6.2		0.9	0.97 J	0.5 U	0.5 U	0.5 U	0.5 U	2.2	0.45 J
TRICHLOROETHENE	5	0.028	0.73	0.1 U	0.1 U	0.1 U	0.1 U	***9***	0.1 U	NA	0.1 U
TOTAL CHLORINATED VOCS				0.1 U	0.1 U	0.1 U	0.1 U	9.43	0.1 U	0.1 U	0.1 U
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)											
NAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
LOW MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TOTAL PAHS			0.0775	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
PESTICIDES/PCBS (UG/L)											
ALPHA-CHLORDANE	2	0.19		0.01 U	0.062	0.0115 J	0.097	0.01 U	0.06 J	0.01 U	0.01 U
DIELDRIN		0.0042		0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.0042 J	0.004 U	0.004 U
GAMMA-CHLORDANE	2	0.015		0.01 U	***0.042***	0.01 U	***0.063***	0.01 U	***0.043***	0.01 U	0.01 U
HEPTACHLOR EPOXIDE	0.2	0.0074		0.01 U	***0.012***	0.01 U	***0.02***	0.01 U	***0.01 J***	0.01 U	0.01 U
AROCLOR-1248		0.034		0.2 U	***0.25 J***	***0.17***	1.2 UJ	0.2 U	***0.6 J***	0.2 U	0.2 U
TOTAL AROCLOR	0.5	0.034		0.2 U	***0.25***	***0.17***	0.2 U	0.2 U	***0.6***	0.2 U	0.2 U
METALS (UG/L)											
ALUMINUM		3600	15341.35	55.6	56.3 J	1010 J	44.3 J	518 J	69 J	250 J	43.7 J
ARSENIC	10	0.045		***0.134 J***	0.1 U	***0.449 J***	***0.136 J***	***0.386 J***	***1.44***	***0.315 J***	***0.124 J***
BARIUM	2000	260	181.32	16.4 J	16.8 J	18.4 J	11.5 J	18.6 J	10.5 J	9.42 J	11.5 J
BERYLLIUM	4	7.3	0.77	0.043 U	0.043 U	0.129 J	0.043 U	0.043 U	0.043 U	0.043 U	0.043 U
CADMIUM	5	1.8		0.094 U	0.094 U	0.084 J	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
CALCIUM			19187.09	33100	14200 J	15200 J	16500 J	35500 J	34200 J	29100 J	14000 J
CHROMIUM	100	11	18.1	0.639 UJ	0.44 UJ	1.57 J	0.302 UJ	1.27 UJ	0.645 UJ	0.847 UJ	0.514 UJ
COBALT		73	8.5	0.522 UJ	0.592 UJ	3.86 J	2 J	0.295 UJ	0.308 UJ	0.809 UJ	1.43 J
COPPER	1300	150	13.5	0.898 UJ	0.654 J	3.33 J	0.553 J	0.75 J	0.702 J	1.52 J	1.76 J

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW03D-1106	B82-GW-MW07D-1006	B82-GW-MW08-016D-1006-AVG	B82-GW-MW09D-1006	B82-GW-MW10D-1006	B82-GW-MW11D-1006	B82-GW-MW200D-1006	B82-GW-MW201D-1006
LOCATION				B82-MW-03D	B82-MW-07D	B82-MW08-016D	B82-MW-09D	B82-MW-10D	B82-MW-11D	B82-MW-200D	B82-MW-201D
TOP DEPTH											
BOTTOM DEPTH											
SAMPLE DATE	MCL	PRG	BKG	11/01/06	10/25/06	10/26/06	10/27/06	10/27/06	10/30/06	10/26/06	10/25/06
METALS (UG/L) (cont.)											
IRON		1100	44137.52	211	196 J	***2280 J***	659 J	938 J	159 J	408 J	144 J
LEAD	15			0.075 U	0.114 J	1.09 J	0.103 J	0.178 J	0.075 UJ	0.196 J	0.075 UJ
MAGNESIUM			14205.47	16800	6780 J	7340 J	5970 J	9830 J	4340 J	13700 J	6510 J
MANGANESE		88	2680.63	***541***	8.15 J	***762***	***154***	***821***	4.51 J	***584***	***385***
MERCURY	2	1.1		0.018 UJ	0.0186 UJ	0.0428 UJ	0.0486 UJ	0.045 UJ	0.0258 UJ	0.018 U	0.0428 UJ
NICKEL		73		2.56 J	1.08 UJ	9.94 J	2.02 J	1.78 UJ	1.36 UJ	2.59 J	3.97 J
POTASSIUM			6177.62	2790	804	1680	926	2740	1930	2560	2060
SILVER		18		0.085 U	0.085 U	0.085 U	0.085 U	0.085 U	0.085 U	0.0857 J	0.085 U
SODIUM			47342.14	20000	18700 J	20800 J	16200 J	16200 J	17000 J	22600 J	24600 J
VANADIUM		3.6	22.6	0.552 J	0.394 UJ	3.31 J	0.202 UJ	0.803 J	2.85 J	0.997 J	0.247 UJ
ZINC		1100	51.7	3.18 UJ	5.28 J	11.4 J	2.72 J	6.32 J	1.8 UJ	4.04 J	7.74 J
MISCELLANEOUS PARAMETERS (MG/L)											
AMMONIA-N				NA	NA	0.155	NA	NA	0.2 U	NA	0.2 U
CHLORIDE	250			NA	NA	14.5	NA	NA	14	NA	11
NITRATE	10	1		NA	NA	0.36	NA	NA	0.3	NA	0.51
SULFATE	250			NA	NA	23	NA	NA	21	NA	26
TOTAL ORGANIC CARBON				NA	NA	0.8	NA	NA	1.3	NA	1.3
FIELD (MG/L)											
FERROUS IRON				NA	NA	0.03 U	NA	NA	0.1	NA	0.03 U

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID				B82-GW-MW202D-1006	B82-GW-MW203D-1106	B82-GW-MW204D-1106-AVG
LOCATION				B82-MW-202D	B82-MW-203D	B82-MW-204D
TOP DEPTH						
BOTTOM DEPTH						
SAMPLE DATE	MCL	PRG	BKG	10/27/06	11/03/06	11/01/06
VOLATILE ORGANIC COMPOUNDS (UG/L)						
1,1,1-TRICHLOROETHANE	200	320		0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROTRIFLUOROETHANE		5900		0.32 J	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	70	6.1		0.58	0.5 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1		0.58	0.5 U	0.5 U
ACETONE		550		5 UJ	5 UJ	5 UJ
CARBON DISULFIDE		100		0.5 U	0.5 U	0.5 U
DICHLORODIFLUOROMETHANE		39		0.5 U	0.5 U	0.5 U
METHYL TERT-BUTYL ETHER		6.2		0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	0.73	***3.1***	***0.24***	0.1 U
TOTAL CHLORINATED VOCS				3.68	0.24	0.1 U
SEMIVOLATILE ORGANIC COMPOUNDS (UG/L)						
NAPHTHALENE		0.62		0.1 U	0.1 U	0.1 U
LOW MOLECULAR WEIGHT PAHS				0.1 U	0.1 U	0.1 U
TOTAL PAHS			0.0775	0.1 U	0.1 U	0.1 U
PESTICIDES/PCBS (UG/L)						
ALPHA-CHLORDANE	2	0.19		0.01 U	0.01 U	0.083 J
DIELDRIN		0.0042		0.004 U	0.004 U	0.004 U
GAMMA-CHLORDANE	2	0.015		0.01 U	0.01 U	***0.056***
HEPTACHLOR EPOXIDE	0.2	0.0074		0.01 U	0.01 U	***0.0135 J***
AROCLOR-1248		0.034		0.2 U	0.2 U	***0.635 J***
TOTAL AROCLOR	0.5	0.034		0.2 U	0.2 U	***0.435***
METALS (UG/L)						
ALUMINUM		3600	15341.35	88.9 J	408	427
ARSENIC	10	0.045		***1.17***	***0.119 J***	0.1 U
BARIUM	2000	260	181.32	16.5 J	11.2 J	22.8 J
BERYLLIUM	4	7.3	0.77	0.043 U	0.043 U	0.0508 J
CADMIUM	5	1.8		0.094 U	0.094 U	0.094 U
CALCIUM			19187.09	34300 J	14500	13400
CHROMIUM	100	11	18.1	0.405 UJ	1.28 U	1.32 U
COBALT		73	8.5	0.419 UJ	1.65 UJ	0.636 UJ
COPPER	1300	150	13.5	1.02 J	1.28 UJ	2.58 U

TABLE 4-9

SUMMARY OF ANALYTICAL DATA[1] - DEEP GROUNDWATER
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID	MCL	PRG	BKG	B82-GW-MW202D-1006	B82-GW-MW203D-1106	B82-GW-MW204D-1106-AVG
LOCATION				B82-MW-202D	B82-MW-203D	B82-MW-204D
TOP DEPTH						
BOTTOM DEPTH						
SAMPLE DATE				10/27/06	11/03/06	11/01/06
METALS (UG/L) (cont.)						
IRON		1100	44137.52	791 J	616	610
LEAD	15			0.115 J	0.462 J	0.502 J
MAGNESIUM			14205.47	9120 J	5420	5800
MANGANESE		88	2680.63	***711***	***228***	59.2
MERCURY	2	1.1		0.174 UJ	0.0916 J	0.0954 J
NICKEL		73		1.78 UJ	4.51 J	2.22 J
POTASSIUM			6177.62	7580	1720	1000
SILVER		18		0.085 U	0.0906 J	0.322 J
SODIUM			47342.14	40900 J	17500	16200
VANADIUM		3.6	22.6	0.222 UJ	0.827 J	0.814 J
ZINC		1100	51.7	3.8 J	6.71 UJ	8.84 UJ
MISCELLANEOUS PARAMETERS (MG/L)						
AMMONIA-N				NA	NA	NA
CHLORIDE	250			NA	NA	NA
NITRATE	10	1		NA	NA	NA
SULFATE	250			NA	NA	NA
TOTAL ORGANIC CARBON				NA	NA	NA
FIELD (MG/L)						
FERROUS IRON				NA	NA	NA

Notes:

1) This table contains the detect and non-detect results for all parameters detected in at least one sample in this media subgroup.
Complete results for all parameters are presented in Appendix F.

PRG - EPA Region IX PRGs for tap water (EPA. 2004) (human health risk based values). The PRG values presented represent a cancer risk level of 10-6 and a hazard quotient of 0.1.

MCL - The lower of the U.S. EPA Maximum Contaminant Level (MCL) for drinking water and the Massachusetts MCL (MMCL).

BKG - NAS South Weymouth Background Value (Stone & Webster, 2002)

Black Background/White print - Primary Criteria Exceeded

Bold Italics (black or gray background) - Secondary Criteria Exceeded

Gray Background - Detected

U - Not Detected

UJ - Detection Limit Approximate

J - Quantitation Limit Approximate

TABLE 4-2
SHALLOW GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-D02-0811	B82-GP-H01-12	B82-GP-H02-13-AVG	B82-GP-H03-10	B82-GW-I05-1115	B82-GW-I06-1115	B82-GP-K05-0610	B82-GP-K08-0610	B82-GP-K09-1014	B82-GP-K10-0610
LOCATION ID			B82-GP-D02	B82-GP-H01	B82-GP-H02	B82-GP-H03	B82-GP-I05	B82-GP-I06	B82-GP-K05	B82-GP-K08	B82-GP-K09	B82-GP-K10
SAMPLE DATE			07/27/06	05/12/09	05/13/09	05/14/09	09/30/09	10/01/09	04/01/10	04/01/10	03/24/10	03/23/10
TOP DEPTH (FT)			8.0	7.0	9.0	6.0	11.0	11.0	6.0	6.0	10.0	6.0
BOTTOM DEPTH (FT)			11.0	12.0	13.0	10.0	15.0	15.0	10.0	10.0	14.0	10.0
SACODE					AVERAGE *							
CRITERIA	**MCL**	**PRG (2004)**										
VOLATILES (UG/L)												
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE		81	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-DICHLOROETHENE	7	34	1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE		1.2	***5.4***	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2	***3***	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACETONE		550	1 U	12	10 U	10 U	5.6 J	15	5 U	5 U	5 U	5 U
BENZENE	5	0.35	***1.3***	1 U	1 U	1 U	0.2 U	0.2 U	0.50 U	0.50 U	0.50 U	0.50 U
CHLOROETHANE		4.6	1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE		66	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
M+P-XYLENES		21	2.9	1 U	1 U	1 U	0.2 U	0.2 U	0.60 J	0.50 U	0.50 U	0.50 U
SEC-BUTYLBENZENE		24	1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	5	0.1	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.50 U	0.50 U	0.50 U	0.50 U
TOLUENE	1000	72	1 U	0.2 J	1 U	1 U	0.2 U	0.2 U	2.4	0.50 U	0.50 U	0.50 U
TOTAL BTEX			4.2	0.2 J	1 U	1 U	0.2 U	0.2 U	3 J	0.5 U	0.5 U	0.5 U
TOTAL CHLORINATED ETHENES			1 U	1 U	1.05	0.7 J	0.2 U	0.2 U	0.5 U	0.6 J	5	1.1
TOTAL CHLORINATED VOCS			1 U	1 U	1.05	0.7 J	0.2 U	0.2 U	0.5 U	0.6 J	5	1.1
TOTAL XYLENES		21	2.9	1 U	1 U	1 U	0.2 U	0.2 U	0.6 J	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	1 U	1 U	***1.05***	***0.7 J***	0.2 U	0.2 U	0.50 U	***0.60 J***	***5***	***1.1***

BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED; U-NOT DETECTED;
J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-2
SHALLOW GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-D02-0811	B82-GP-H01-12	B82-GP-H02-13-AVG	B82-GP-H03-10	B82-GW-I05-1115	B82-GW-I06-1115	B82-GP-K05-0610	B82-GP-K08-0610	B82-GP-K09-1014	B82-GP-K10-0610
LOCATION ID			B82-GP-D02	B82-GP-H01	B82-GP-H02	B82-GP-H03	B82-GP-I05	B82-GP-I06	B82-GP-K05	B82-GP-K08	B82-GP-K09	B82-GP-K10
SAMPLE DATE			07/27/06	05/12/09	05/13/09	05/14/09	09/30/09	10/01/09	04/01/10	04/01/10	03/24/10	03/23/10
TOP DEPTH (FT)			8.0	7.0	9.0	6.0	11.0	11.0	6.0	6.0	10.0	6.0
BOTTOM DEPTH (FT)			11.0	12.0	13.0	10.0	15.0	15.0	10.0	10.0	14.0	10.0
SACODE					AVERAGE *							
CRITERIA	**MCL**	**PRG (2004)**										

* AVERAGE - average of sample and duplicate results

TABLE 4-2
SHALLOW GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GW-MW01-1006	B82-GW-MW03-1006	B82-GW-MW10S-1006	B82-GW-MW202S-1006	B82-GW-MW203S-1106
LOCATION ID			B82-MW-01	B82-MW-03	B82-MW-10S	B82-MW-202S	B82-MW-203S
SAMPLE DATE			10/30/06	10/30/06	10/31/06	10/31/06	11/02/06
TOP DEPTH (FT)			5.0	4.8	6.0	7.0	4.0
BOTTOM DEPTH (FT)			14.6	14.4	16.0	17.0	14.0
SACODE							
CRITERIA	**MCL**	**PRG (2004)**					
VOLATILES (UG/L)							
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	0.66	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE		81	18	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	7	34	1.6	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-TRIMETHYLBENZENE		1.2	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE		1.2	NA	NA	NA	NA	NA
ACETONE		550	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
BENZENE	5	0.35	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CHLOROETHANE		4.6	2.6	0.5 U	0.5 U	0.5 U	0.5 U
ISOPROPYLBENZENE		66	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
M+P-XYLENES		21	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE		24	NA	NA	NA	NA	NA
TETRACHLOROETHENE	5	0.1	0.1 U	***0.14***	0.1 U	0.1 U	***0.4***
TOLUENE	1000	72	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOTAL BTEX			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TOTAL CHLORINATED ETHENES			1.6	0.14	0.11	0.94	0.4
TOTAL CHLORINATED VOCS			22.2	0.14	0.11	0.94	0.4
TOTAL XYLENES		21	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	0.1 U	0.1 U	***0.11***	***0.94***	0.1 U

BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED; U-NOT DETECTED;
J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-2
SHALLOW GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GW-MW01-1006	B82-GW-MW03-1006	B82-GW-MW10S-1006	B82-GW-MW202S-1006	B82-GW-MW203S-1106
LOCATION ID			B82-MW-01	B82-MW-03	B82-MW-10S	B82-MW-202S	B82-MW-203S
SAMPLE DATE			10/30/06	10/30/06	10/31/06	10/31/06	11/02/06
TOP DEPTH (FT)			5.0	4.8	6.0	7.0	4.0
BOTTOM DEPTH (FT)			14.6	14.4	16.0	17.0	14.0
SACODE							
CRITERIA	**MCL**	**PRG (2004)**					
			* AVERAGE - average of sample and duplicate results				

SAMPLE ID			B82-GP-B03-2023	B82-GP-C01-2023	B82-GP-C02-2730	B82-GP-C04-2023	B82-GP-D01-1720	B82-GP-D01-2730	B82-GP-D02-3740	B82-GP-D02-4346	B82-GP-E03-1719	B82-GP-E03-1921
LOCATION ID			B82-GP-B03	B82-GP-C01	B82-GP-C02	B82-GP-C04	B82-GP-D01	B82-GP-D01	B82-GP-D02	B82-GP-D02	B82-GP-E03	B82-GP-E03
SAMPLE DATE			07/21/06	07/25/06	07/26/06	07/31/06	07/27/06	07/27/06	07/28/06	07/28/06	08/04/06	08/04/06
TOP DEPTH (FT)			20.0	20.0	27.0	20.0	17.0	27.0	37.0	43.0	17.0	19.0
BOTTOM DEPTH (FT)			23.0	23.0	30.0	23.0	20.0	30.0	40.0	46.0	19.0	21.0
SACODE												
CRITERIA	MCL	PRG (2004)										
VOLATILES (UG/L)												
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	NA	NA	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
ACETONE		550	1 U	1 U	1 U	1 U	1 U	1 U	1 U	4.6	1 U	1 U
BENZENE	5	0.35	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
CHLOROFORM	80	0.17	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 UJ	1 UJ	***4.6***	***1.4***
CIS-1,2-DICHLOROETHENE	70	6.1	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U	1 U
DICHLORODIFLUOROMETHANE		39	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
M+P-XYLENES		21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
METHYL TERT-BUTYL ETHER		6.2	1.9	1.4	1.8 J	1 U	1 U	1 U	1.2	1 U	1 U	1 U
TOLUENE	1000	72	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL BTEX			1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TOTAL CHLORINATED ETHENES			1 U	1 U	1 U	4.7 J	1.2	1.7	1 U	1 U	1.8	2.7
TOTAL CHLORINATED VOCS			1 U	1 U	1 U	4.7	1.2	1.7	1 U	1 U	6.4	4.1
TOTAL XYLENES		21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5	0.028	1 U	1 U	1 U	***3.7 J***	***1.2***	***1.7***	1 U	1 U	***1.8***	***2.7***

DARK SHADING-MCL EXCEEDED; BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-3
DEEP GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-H01-22	B82-GP-H01-30	B82-GP-H02-23	B82-GP-H03-19	B82-GP-H03-28	B82-GP-H04-20	B82-GP-H04-30	B82-GW-I01-1217	B82-GW-I01-1519	B82-GW-I02-1317
LOCATION ID			B82-GP-H01	B82-GP-H01	B82-GP-H02	B82-GP-H03	B82-GP-H03	B82-GP-H04	B82-GP-H04	B82-GP-I01	B82-GP-I01	B82-GP-I02
SAMPLE DATE			05/13/09	05/14/09	05/13/09	05/14/09	05/14/09	05/15/09	05/15/09	09/23/09	09/25/09	09/24/09
TOP DEPTH (FT)			17.0	26.0	19.0	15.0	24.0	16.0	26.0	12.0	15.0	13.0
BOTTOM DEPTH (FT)			22.0	30.0	23.0	19.0	28.0	20.0	30.0	17.0	19.0	17.0
SACODE												
CRITERIA	MCL	PRG (2004)										
VOLATILES (UG/L)												
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACETONE		550	8.9 J	10 U	10 U	10 U	10 U	10 U	10 U	5 U	5 U	5 U
BENZENE	5	0.35	0.2 J	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
CHLOROFORM	80	0.17	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
CIS-1,2-DICHLOROETHENE	70	6.1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE		39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
M+P-XYLENES		21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
METHYL TERT-BUTYL ETHER		6.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	1000	72	0.2 J	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
TOTAL BTEX			0.4 J	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
TOTAL CHLORINATED ETHENES			1.7	5.9	2.8	1.3	6.5	8.5	2.5	2.5	2.2	1.2
TOTAL CHLORINATED VOCS			1.7	5.9	2.8	1.3	6.5	8.5	2.5	2.5	2.2	1.2
TOTAL XYLENES		21	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U
TRICHLOROETHENE	5	0.028	***1.7***	***5.9***	***2.8***	***1.3***	***6.5***	***8.5***	***2.5***	***2.5***	***2.2***	***1.2***

DARK SHADING-MCL EXCEEDED; BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-3
DEEP GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GW-I02-2024	B82-GW-I02-2428	B82-GW-I03-2630	B82-GW-I03-1822-AVG	B82-GW-I04-2428	B82-GW-I05-1822	B82-GW-I06-1620-AVG	B82-GW-I06-1822	B82-GW-I07-1822-AVG	B82-GW-I08-1822
LOCATION ID			B82-GP-I02	B82-GP-I02	B82-GP-I03	B82-GP-I03	B82-GP-I04	B82-GP-I05	B82-GP-I06	B82-GP-I06	B82-GP-I07	B82-GP-I08
SAMPLE DATE			09/24/09	09/24/09	09/28/09	09/28/09	09/29/09	09/30/09	09/30/09	10/01/09	10/02/09	10/05/09
TOP DEPTH (FT)			20.0	24.0	26.0	18.0	24.0	18.0	16.0	18.0	18.0	18.0
BOTTOM DEPTH (FT)			24.0	28.0	30.0	22.0	28.0	22.0	20.0	22.0	22.0	22.0
SACODE						AVERAGE			AVERAGE		AVERAGE	
CRITERIA	MCL	PRG (2004)										
VOLATILES (UG/L)												
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACETONE		550	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
BENZENE	5	0.35	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROFORM	80	0.17	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CIS-1,2-DICHLOROETHENE	70	6.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
DICHLORODIFLUOROMETHANE		39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
M+P-XYLENES		21	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
METHYL TERT-BUTYL ETHER		6.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	1000	72	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL BTEX			0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL CHLORINATED ETHENES			7.2	12	1	0.3 J	0.2 J	0.3 J	0.55 J	2.8	0.3 J	4.5
TOTAL CHLORINATED VOCS			7.2	12	1	0.3 J	0.2 J	0.3 J	0.55 J	2.8	0.3 J	4.5
TOTAL XYLENES		21	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TRICHLOROETHENE	5	0.028	***7.2***	***12***	***1***	***0.3 J***	***0.2 J***	***0.3 J***	***0.55 J***	***2.8***	***0.3 J***	***4.5***

DARK SHADING-MCL EXCEEDED; BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-3
DEEP GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-J01-2021	B82-GP-J02-2022	B82-GP-J03-2024-AVG	B82-GP-J04-2021.5-AVG	B82-GP-J05-2022	B82-GP-J07-2125	B82-GP-K01-1519	B82-GP-K03-1620	B82-GP-K04-1721	B82-GP-K05-1519	B82-GP-K06-1620	B82-GP-K07-1721
LOCATION ID			B82-GP-J01	B82-GP-J02	B82-GP-J03	B82-GP-J04	B82-GP-J05	B82-GP-J07	B82-GP-K01	B82-GP-K03	B82-GP-K04	B82-GP-K05	B82-GP-K06	B82-GP-K07
SAMPLE DATE			12/17/09	12/14/09	12/17/09	12/15/09	12/15/09	12/18/09	03/25/10	03/22/10	03/23/10	04/01/10	03/31/10	03/22/10
TOP DEPTH (FT)			20.0	20.0	20.0	20.0	20.0	21.0	15.0	16.0	17.0	15.0	16.0	17.0
BOTTOM DEPTH (FT)			21.0	22.0	24.0	21.5	22.0	25.0	19.0	20.0	21.0	19.0	20.0	21.0
SACODE					AVERAGE	AVERAGE								
CRITERIA	MCL	PRG (2004)												
VOLATILES (UG/L)														
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ACETONE		550	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
BENZENE	5	0.35	0.5 U	0.5 U	0.50 U	0.50 U	0.5 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
CHLOROFORM	80	0.17	0.5 U	0.5 U	0.50 U	0.50 U	0.5 U	0.5 U	0.50 U	***1.2***	0.50 U	0.50 U	0.50 U	0.50 U
CIS-1,2-DICHLOROETHENE	70	6.1	0.5 U	0.5 U	0.50 U	0.50 U	0.5 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
DICHLORODIFLUOROMETHANE		39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
M+P-XYLENES		21	0.5 U	0.5 U	0.50 U	0.50 U	0.5 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 J	0.50 U	0.50 U
METHYL TERT-BUTYL ETHER		6.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOLUENE	1000	72	0.5 U	0.5 U	0.50 U	0.50 U	0.5 U	0.5 U	0.50 U	0.50 U	0.50 U	0.70 J	0.50 U	0.50 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOTAL BTEX			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2 J	0.5 U	0.5 U
TOTAL CHLORINATED ETHENES			5	14	21	1.65	14	0.71 J	2.3	5.3	1.3	2.2	4.4	18
TOTAL CHLORINATED VOCS			5	14	21	1.65	14	0.71 J	2.3	5.3	1.3	2.2	4.4	18
TOTAL XYLENES		21	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 J	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	***5***	***14***	***21***	***1.65***	***14***	***0.71 J***	***2.3***	***5.3***	***1.3***	***2.2***	***4.4***	***18***

DARK SHADING-MCL EXCEEDED; BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-3
DEEP GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-K08-1721	B82-GP-K09-1620	B82-GP-K10-1620	B82-GP-K11-1822	B82-GP-K12-2024	B82-GP-K13-1519	B82-GW-MW03D-1106	B82-GW-MW10D-1006	B82-GW-MW201D-1006	B82-GW-MW202D-1006	B82-GW-MW203D-1106
LOCATION ID			B82-GP-K08	B82-GP-K09	B82-GP-K10	B82-GP-K11	B82-GP-K12	B82-GP-K13	B82-MW-03D	B82-MW-10D	B82-MW-201D	B82-MW-202D	B82-MW-203D
SAMPLE DATE			04/01/10	03/24/10	03/23/10	03/25/10	03/31/10	03/26/10	11/01/06	10/27/06	10/25/06	10/27/06	11/03/06
TOP DEPTH (FT)			17.0	16.0	16.0	18.0	20.0	15.0	26.0	32.0	20.0	26.0	28.0
BOTTOM DEPTH (FT)			21.0	20.0	20.0	22.0	24.0	19.0	36.0	42.0	25.0	36.0	38.0
SACODE													
CRITERIA	MCL	PRG (2004)											
VOLATILES (UG/L)													
1,1,2-TRICHLOROTRIFLUOROETHANE		5900	NA	NA	NA	NA	NA	NA	0.5 U	0.35 J	0.5 U	0.32 J	0.5 U
ACETONE		550	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ	5 UJ
BENZENE	5	0.35	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
CHLOROFORM	80	0.17	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.46 U	0.1 U	0.94 U	0.4 U	0.8 U
CIS-1,2-DICHLOROETHENE	70	6.1	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.5 U	0.43 J	0.5 U	0.58	0.5 U
DICHLORODIFLUOROMETHANE		39	NA	NA	NA	NA	NA	NA	2.7	0.5 U	0.5 UJ	0.5 U	0.5 U
M+P-XYLENES		21	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	NA	NA	NA	NA	NA
METHYL TERT-BUTYL ETHER		6.2	NA	NA	NA	NA	NA	NA	0.9	0.5 U	0.45 J	0.5 U	0.5 U
TOLUENE	1000	72	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.43	0.5 U	0.58	0.5 U
TOTAL BTEX			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TOTAL CHLORINATED ETHENES			21	25	4.5	4.5	2.5	2.6	0.26 U	9.43	0.26 U	3.68	0.24
TOTAL CHLORINATED VOCS			21	25	4.5	4.5	2.5	2.6	0.1 U	9.43	0.1 U	3.68	0.24
TOTAL XYLENES		21	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	5	0.028	***21***	***25***	***4.5***	***4.5***	***2.5***	***2.6***	0.1 U	***9***	0.1 U	***3.1***	***0.24***

DARK SHADING-MCL EXCEEDED; BOLD/ITALIC-PRG EXCEEDED; LIGHT SHADING - DETECTED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

TABLE 4-4
L-SERIES GROUNDWATER ANALYTICAL RESULTS
BUILDING 82 SITE
FORMER NAS SOUTH WEYMOUTH WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GP-L01-0912	B82-GP-L01-1214	B82-GP-L01-1720
LOCATION ID			B82-GP-L01	B82-GP-L01	B82-GP-L01
SAMPLE DATE			03/29/10	03/29/10	03/29/10
TOP DEPTH (FT)			9.0	12.0	14.0
BOTTOM DEPTH (FT)			12.0	14.0	20.0
CRITERIA	MCL	PRG (2004)			
VOLATILES (UG/L)					
1,1,1-TRICHLOROETHANE	200	320	0.50 U	0.50 U	0.50 U
1,1,2,2-TETRACHLOROETHANE		0.055	0.50 U	0.50 U	0.50 U
1,1-DICHLOROETHANE		81	0.50 U	0.50 U	0.50 U
1,2-DICHLOROETHANE	5	0.12	0.50 U	0.50 U	0.50 U
1,2-DICHLOROPROPANE	5	0.16	0.50 U	0.50 U	0.50 U
2-BUTANONE		700	5 U	5 U	5 U
2-HEXANONE			5 U	5 U	5 U
4-METHYL-2-PENTANONE		200	5 U	5 U	5 U
ACETONE		550	5 UJ	5 UJ	5 UJ
BENZENE	5	0.35	0.50 U	0.50 U	0.50 U
BROMODICHLOROMETHANE	80	0.18	0.50 U	0.50 U	0.50 U
CHLOROFORM	80	0.17	0.50 U	0.50 U	0.50 U
CIS-1,2-DICHLOROETHENE	70	6.1	0.50 U	0.50 U	0.50 U
ETHYLBENZENE	700	130	0.50 U	0.50 U	0.50 U
M+P-XYLENES		21	0.50 U	0.50 U	0.50 U
METHYLENE CHLORIDE	5	4.3	0.50 U	0.50 U	0.50 U
O-XYLENE		21	0.50 U	0.50 U	0.50 U
TETRACHLOROETHENE	5	0.1	0.50 U	0.50 U	0.50 U
TOLUENE	1000	72	0.50 U	0.50 U	0.50 U
TOTAL 1,2-DICHLOROETHENE	5	6.1	0.5 U	0.5 U	0.5 U
TOTAL BTEX			0.5 U	0.5 U	0.5 U
TOTAL CHLORINATED ETHENES			0.5 U	0.5 U	0.5 U
TOTAL XYLENES		21	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	100	12	0.50 U	0.50 U	0.50 U
TRICHLOROETHENE	5	0.028	0.50 U	0.50 U	0.50 U
VINYL CHLORIDE	2	0.02	0.50 U	0.50 U	0.50 U

TABLE 4-5
GROUNDWATER ANALYTICAL RESULTS - PCBs
BUILDING 82
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
PAGE 1 OF 2

SAMPLE ID			MW7D	B82-GW-MW07D-1006	B82-GW-MW7D-1009	B82-GW-MW08-016D-1006	B82-GW-MW08-016D-1006-D	B82-GW-MW08-016D-1006-AVG	B82-GW-MW08-16D-1009	MW11D	B82-GW-MW11D-1006	B82-GW-MW11D-1009
LOCATION ID			B82-MW-07D	B82-MW-07D	B82-MW-07D	B82-MW08-016D	B82-MW08-016D	B82-MW08-016D	B82-MW08-016D	B82-MW-11D	B82-MW-11D	B82-MW-11D
SAMPLE DATE			05/21/03	10/25/06	10/02/09	10/26/06	10/26/06	10/26/06	10/06/09	05/20/03	10/30/06	10/05/09
TOP DEPTH (FT)			21.5	21.5	21.5	22.0	22.0	22.0	22.0	26.0	26.0	26.0
BOTTOM DEPTH (FT)			31.5	31.5	31.5	32.0	32.0	32.0	32.0	36.0	36.0	36.0
SACODE							DUPLICATE	AVERAGE				
CRITERIA	MCL	PRG										
PCBS (UG/L)												
AROCLOR-1016		0.96	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
AROCLOR-1221		0.03	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
AROCLOR-1232		0.03	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
AROCLOR-1242		0.03	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
AROCLOR-1248		0.03	0.5 U	***0.25 J***	0.1 U	***0.24***	0.2 U	***0.17***	0.1 U	0.5 U	***0.6 J***	0.1 U
AROCLOR-1254		0.03	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
AROCLOR-1260		0.03	0.5 U	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.5 U	0.2 U	0.1 U
TOTAL AROCLOR	0.5	0.03	0.5 U	***0.25***	0.1 U	***0.24***	0.2 U	***0.17***	0.1 U	0.5 U	***0.6***	0.1 U
FILTERED PCBS (UG/L)												
AROCLOR-1016		0.96	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1221		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1232		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1242		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1248		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1254		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
AROCLOR-1260		0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U
TOTAL AROCLOR	0.5	0.03	NA	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	0.1 U

TABLE 4-5
GROUNDWATER ANALYTICAL RESULTS - PCBs
BUILDING 82
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

SAMPLE ID			B82-GW-MW203S-1106	B82-GW-MW203S-1009	B82-GW-MW204D-1106	B82-GW-MW204D-1106-D	B82-GW-MW204D-1106-AVG	B82-GW-MW204D-1009	B82-GW-MW204D-1009-D	B82-GW-MW204D-1009-AVG
LOCATION ID			B82-MW-203S	B82-MW-203S	B82-MW-204D	B82-MW-204D	B82-MW-204D	B82-MW-204D	B82-MW-204D	B82-MW-204D
SAMPLE DATE			11/02/06	10/05/09	11/01/06	11/01/06	11/01/06	10/07/09	10/07/09	10/07/09
TOP DEPTH (FT)			4.0	4.0	28.0	28.0	28.0	28.0	28.0	28.0
BOTTOM DEPTH (FT)			14.0	14.0	41.0	41.0	41.0	41.0	41.0	41.0
SACODE						DUPLICATE	AVERAGE		DUPLICATE	AVERAGE
CRITERIA	MCL	PRG								
PCBS (UG/L)										
AROCLOR-1016		0.96	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
AROCLOR-1221		0.03	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
AROCLOR-1232		0.03	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
AROCLOR-1242		0.03	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
AROCLOR-1248		0.03	0.2 U	0.1 U	***0.77 J***	1 UJ	***0.635 J***	0.1 U	0.1 U	0.1 U
AROCLOR-1254		0.03	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
AROCLOR-1260		0.03	0.028 J	0.1 U	0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U
TOTAL AROCLOR	0.5	0.03	0.028	0.1 U	***0.77***	0.2 U	***0.435***	0.1 U	0.1 U	0.1 U
FILTERED PCBS (UG/L)										
AROCLOR-1016		0.96	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1221		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1232		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1242		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1248		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1254		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
AROCLOR-1260		0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U
TOTAL AROCLOR	0.5	0.03	NA	0.1 U	NA	NA	NA	0.1 U	0.1 U	0.1 U

BOLD/ITALIC-PRG EXCEEDED;
U-NOT DETECTED; J-QUANTITATION APPROXIMATE; R-REJECTED; NA-NOT ANALYZED

APPENDIX B

HUMAN HEALTH RISK CALCULATIONS

EXAMPLE PRG CALCULATION
BUILDING 82 FEASIBILITY STUDY
NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

COCs in Groundwater (Tapwater)	Units	EPC (Maximum Concentration)	MCL/MCLG	Estimated Risk	Potential PRGs		
					CR = 1E-06	CR = 1E-05	HI = 1
Trichloroethene*	ug/L	9	5	ILCR = 2E-06	4.5	45	NA
Aroclor-1248	ug/L	0.635	0.5	ILCR = 2E-05	0.032	0.32	NA
n-nitroso-di-n-propylamine	ug/L	0.29	--	ILCR = 4E-05	0.0073	0.073	NA
1,1-dichloroethane	ug/L	99	--	ILCR = 1E-05, HI = 0.05	9.9	99	1980

Notes:
Cancer risk is based on lifelong resident; non-cancer risk is based on child resident.
*The vapor intrusion risk has been added to TCE.
MCLs/MCLGs and PRGs at cancer risk (CR) of 1E-06 are presented for information purposes.
Inhalation risks were not included in the estimated risks presented in accordance with EPA New England Region I Risk Update Number 3 (August, 1995), which states, “In the interim, EPA New England adopted an approach of qualitatively assessing the exposure and risk from the inhalation pathway as being equal to that of the ingestion pathway for volatile organic compounds.” The August 1995 risk update also states, “This qualitative assessment of risks will not be factored in to the derivation of groundwater cleanup levels.”

This Table presents potential PRG values calculated using the EPCs and risk estimates for each COC. Potential PRGs were calculated according to the following equation:

$$(EPC \times TR)/ER$$

Where:

EPC	=	Exposure point concentration - maximum concentration for groundwater COPCs (µg/L)
TR	=	Target risk (1E-05 for cancer risk or HI = 1 for non-cancer risk)

ER	=	Estimated risk (ingestion and dermal) found the Draft Final RI, Appendix G-1, Tables 9.9A.RME and 9.9B.RME (lifelong resident) for cancer risk and Tables 9.6A.RME and 9.6B.RME (child resident) for non-cancer risk

Maximum concentrations were used as EPCs for groundwater contamination. Final PRGs were selected using a target cancer risk of $1x10^{-5}$ for cancer risk or an HI of 1 for non-cancer risk. Estimated risk is the risk (cancer or non-cancer) calculated for each COC in the RME scenario. The cancer risk is for the lifelong resident receptor, and the non-cancer risk is for the child resident receptor.

CALCULATION WORKSHEET

CLIENT: NAS SOUTH WEYMOUTH		**JOB NUMBER:** 02073
SUBJECT: CALCULATION OF PRGS FOR COC IN GROUNDWATER LIFELONG RESIDENT (CANCER) AND CHILD RESIDENT (NON-CANCER)		
BY: L. CIOFANI	JAS	**DATE:** 10/16/09

PURPOSE: To calculate PRGs based on carcinogenic and non-carcinogenic risks from COC in groundwater.

EQUATION:

$$PRG = \frac{EPC \times TR}{ER}$$

Where:

PRG = Preliminary Remediation Goal (µg/L)
EPC = Exposure Point Concentration (µg/L)
TR = Target risk, cancer (1E-05) or non-cancer (HI=1)
ER = Estimated risk from risk assessment

Chemical: 1,1-DCA

EXAMPLE CARCINOGENIC CALCULATION

$$PRGc = \frac{99\ \mu g/L \times 1E\text{-}05}{1E\text{-}05}$$

PRGc = 99 µg/L

EXAMPLE NONCARCINOGENIC CALCULATION

$$PRGn = \frac{99\ ug/L \times 1}{0.05}$$

PRGn = 1,980 µg/L

RISK ASSESSMENT SPREADSHEET - CLEANUP LEVELS

SITE NAME: **NAS SOUTH WEYMOUTH**
LOCATION: **BUILDING 82**
EXPOSURE SCENARIO: **CHILD RESIDENT**
MEDIA: **GROUNDWATER**
DATE: **MARCH 6, 2012**

THIS SPREADSHEET CALCULATES CLEANUP LEVELS FOR EXPOSURES TO GROUNDWATER
VIA INGESTION AND DERMAL CONTACT

RELEVANT EQUATIONS:

$$C_w = \frac{TCR \cdot BW \cdot AT}{EF \cdot ED} \cdot \frac{1}{(IR \cdot CSF_{oral} + DAevent \cdot SA \cdot CSF_{derm})}$$

$$C_w = \frac{THI \cdot BW \cdot AT}{EF \cdot ED} \cdot \frac{1}{\left(\frac{IR}{RfD_{oral}} + \frac{DAevent \cdot EV \cdot SA}{RfD_{derm}}\right)}$$

For Inorganics DAevent = Kp x Cw x CF x tevent

For Organics If $tevent \leq t^*$, then : $DAevent = 2 \times Kp \times Cw \times CF \times \sqrt{\frac{6 \times tau \times tevent}{\pi}}$

If $tevent > t^*$, then : $DAevent = Kp \times Cw \times CF \times \left[\frac{tevent}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$

Where:

TCR = :	1.00E-06	Target Cancer Risk
THI = :	1	Target Hazard Index
IR = :	1.5	Water Ingestion Rate (L/day)
SA = :	6,600	Skin surface available for contact (cm^2)
DAevent = :		Chemical specific absorbed dose per event (mg/cm^2-event)
EV = :	1	Event frequency (events/days)
EF = :	350	Exposure frequency (days/year)
ED = :	6	Exposure duration (years)
BW = :	15	Body weight (kg)
ATc = :	25,550	Averaging time for carcinogenic exposures (days)
ATn = :	2,190	Averaging time for noncarcinogenic exposures (days)
CF = :	0.001	Conversion Factor (L/m^3)

Kp =:		Chemical specific permeability coefficient (cm/hr)
Cw = :		Concentration of chemical in water (mg/L)
tevent = :	1	duration of event (hr/event)
tau = :		Chemical specific lag time (hr)
t* = :		Chemical specific time it takes to reach steady state (hr)
B = :		Chemical specific dimensionless constant
FA = :		Fraction absorbed (dimensionless)

RISK ASSESSMENT SPREADSHEET - INGESTION AND DIRECT DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: NAS SOUTH WEYMOUTH
LOCATION: BUILDING 82
EXPOSURE SCENARIO: CHILD RESIDENT
MEDIA: GROUNDWATER
DATE: MARCH 6, 2012

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DAevent (mg/cm^2 - event)
Manganese	I	1.00E-03	1	NA	NA	NA	1.00E-06

CHEMICAL	DAevent (mg/cm^2 - event)	Cancer Slope Factor		Reference Dose		Cleanup Level	Cleanup Level
		Oral (mg/kg/day)$^{-1}$	Dermal (mg/kg/day)$^{-1}$	Oral (mg/kg/day)$^{-1}$	Dermal (mg/kg/day)$^{-1}$	Carc. (mg/L)	Noncarc. (mg/L)
Manganese	1.00E-06	NA	NA	2.40E-02	9.60E-04	NA	2.25E-01

TABLE 6-4

SUMMARY OF RECEPTOR RISKS AND HAZARDS
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario/ Receptor	Media	Lead (1)	CR>1E-04 or HI>1	Total Cancer Risks (RME)	Major contributors to cancer risk above 1E-04 (those with individual cancer risk>1E-06**)	Total Noncancer Hazard Index (RME)	Major contributors to noncancer Hazard Index above 1.0 (those with HQ greater than 0.1***)
Current Maintenance Workers	Exposed Surface Soil	Not a COPC	NO	4E-06	NA	0.01	NA
Trespassers	Exposed Surface Soil, Sediment, and Surface Water	Not a COPC	NO	8E-06	NA	0.02	NA
Adult Recreational Visitors	Surface Soil, Sediment, and Surface Water	Not a COPC	NO	2E-06	NA	0.006	NA
Child Recreational Visitors	Surface Soil, Sediment, and Surface Water	Not a COPC	NO	8E-05	NA	0.2	NA
Lifetime Recreational Visitors	Surface Soil, Sediment, and Surface Water	Not a COPC	NO	8E-05	NA	NA	NA
Adult Residents*	Surface Soil, Sediment, Surface Water, and Groundwater	Not a COPC	YES†	1E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, PCE, Aroclor-1248, Heptachlor epoxide	9	**groundwater** - Manganese (Arsenic, Naphthalene)
Child Residents*	Surface Soil, Sediment, Surface Water, and Groundwater	Not a COPC	YES	2E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, PCE, Aroclor-1248, Heptachlor epoxide	31	**groundwater** - Arsenic, Manganese (Nitrobenzene, Naphthalene, Heptachlor epoxide)
Lifetime Residents*	Surface Soil, Sediment, Surface Water, and Groundwater	Not a COPC	YES	4E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, Benzene, Chloroform, PCE, TCE, Aroclor-1248, Heptachlor epoxide	NA	NA
Adult Residents*	0-8ft Soil, Sediment, Surface Water, and Groundwater	Not Evaluated	YES†	1E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, PCE, Aroclor-1248, Heptachlor epoxide	9	**groundwater** - Manganese (Arsenic, Naphthalene)
Child Residents*	0-8ft Soil, Sediment, Surface Water, Groundwater, Indoor Air	0%	YES	2E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, PCE, Aroclor-1248, Heptachlor epoxide	31	**groundwater** - Arsenic, Manganese (Nitrobenzene, Naphthalene, Heptachlor epoxide)
Lifetime Residents*	0-8ft Soil, Sediment, Surface Water, and Groundwater	Not Evaluated	YES	4E-04	**groundwater** - Arsenic, N-nitroso-di-n-propylamine, 1,1-DCA, Benzene, Chloroform, PCE, TCE, Aroclor-1248, Heptachlor epoxide	NA	NA
Future Industrial Workers*	Surface Soil, Sediment, and Surface Water	Not a COPC	NO	8E-06	NA	0.02	NA
Future Industrial Workers*	0-8ft Soil, Sediment, and Surface Water	0.003%	NO	7E-06	NA	0.05	NA
Construction Workers	0-8ft Soil, Dust, Shallow Groundwater, and Trench Air	Not Evaluated	YES	4E-07	NA	4	**trench air** - (Naphthalene, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene); **dust** - Manganese

TABLE 6-4

SUMMARY OF RECEPTOR RISKS AND HAZARDS
BUILDING 82 SITE
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario/ Receptor	Media	Lead (1)	CR>1E-04 or HI>1	Total Cancer Risks (RME)	Major contributors to cancer risk above 1E-04 (those with individual cancer risk>1E-06**)	Total Noncancer Hazard Index (RME)	Major contributors to noncancer Hazard Index above 1.0 (those with HQ greater than 0.1***)

Notes:

(1) Probability that blood lead levels exceed 10 ug/dL; EPA's goal is that a probability of no more than 5% of individuals will have blood lead concentrations above 10 ug/dL.
NA - Not Applicable
RME - Reasonable Maximum Exposure.

* Future residents and future industrial workers are presented twice to present 1) total hazard indices from all media including future surface soil and 2) total hazard indices from all media including 0 to 8 foot soil.
** Chemicals with cancer risk > 1E-06 in media with cancer risk > 1E-04.
*** Chemicals with hazard quotient (HQ) >0.1 in media with hazard index (HI) > 1.0. Chemicals listed before parenthesis have HQ > 1, chemicals listed in parenthesis have HQ between 0.1 and 1.0.
media shown in bold type - indicates media with cancer risk > 1E-04 or HI > 1.0.
† The cancer risk for the adult resident is approximately equal to 1E-04 and therefore does not exceed 1E-04. However, the major contributors to this cancer risk are presented because the cancer risk for the lifelong resident (adult + child) exceeds 1E-04.

RISK ASSESSMENT SPREADSHEET - CLEANUP LEVELS (PAGE ONE OF THREE)

SITE NAME: **NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS**
LOCATION: **BUILDING 82**
EXPOSURE SCENARIO: **LIFELONG RESIDENT**
MEDIA: **GROUNDWATER**
DATE: **MAY 21, 2012**

THIS SPREADSHEET CALCULATES CLEANUP LEVELS FOR EXPOSURES TO GROUNDWATER
VIA INGESTION, DERMAL CONTACT, AND INHALATION

RELEVANT EQUATIONS:

$$PRG_{GW} = \frac{TCR}{Intake_{ing} \cdot CSF_{oral} + Intake_{derm} \cdot CSF_{derm} + Intake_{inh} \cdot IUR}$$

$$PRG_{GW} = \frac{THI}{\left(\frac{Intake_{ing}}{RfD_{oral}}\right) + \left(\frac{Intake_{derm}}{RfD_{derm}}\right) + \left(\frac{Intake_{inh}}{RfC}\right)}$$

$$Intake_{ing} = \frac{IR \times EF \times ED}{BW \times AT}$$

$$Intake_{derm} = \frac{DA_{Event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

$$Intake_{inh} = \frac{K \times ET \times EF \times ED}{AT \times 24\ hrs/day}$$

For Inorganics DAevent = Kp x CF x tevent

For Organics

$$\text{If } tevent \le t^*, \text{ then : } DAevent = 2 \times Kp \times FA \times CF \times \sqrt{\frac{6 \times tau \times tevent}{\pi}}$$

$$\text{If } tevent > t^*, \text{ then : } DAevent = Kp \times FA \times CF \times \left[\frac{tevent}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

Where:

Parameter	Child	Adult	Definition
TCR = :	1.0E-06	1.0E-06	Target Cancer Risk
THI = :	1	1	Target Hazard Index
IR = :	1.5	2	Ingestion rate (L/day)
SA = :	6,600	18,000	Skin surface available for contact (cm^2)
DAevent = :	Chemical Specific		Absorbed dose per event (mg/cm^2-event)
EV = :	1	1	Event frequency (events/days)
EF = :	350	350	Exposure frequency (days/year)
ED = :	6	24	Exposure duration (years)
ET = :	0	0	Exposure time (hrs/day)
BW = :	15	70	Body weight (kg)
ATc = :	25,550	25,550	Averaging time for carcinogenic exposures (days)
ATn = :	2,190	8,760	Averaging time for noncarcinogenic exposures (days)
CF = :	0.001	0.001	Conversion Factor (L/m^3)
Kp =:	Chemical Specific		Permeability coefficient (cm/hr)
Cw = :	Chemical Specific		Concentration of chemical in water (mg/L)
tevent = :	1	0.58	duration of event (hr/event)
K = :	0.5	0.5	Volatilization Factor (L/m3)
tau = :	Chemical Specific		Lag time (hr)
t* = :	Chemical Specific		Time it takes to reach steady state (hr)
B = :	Chemical Specific		Dimensionless constant
FA = :	Chemical Specific		Fraction absorbed (dimensionless)

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH GROUNDWATER (PAGE TWO OF THREE)

SITE NAME: NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
LOCATION: BUILDING 82
EXPOSURE SCENARIO: LIFELONG RESIDENT
MEDIA: GROUNDWATER
DATE: MAY 21, 2012

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DAevent (L/cm^2- event)	
							Child	Adult
Benzene	Organic	1.49E-02	1	2.92E-01	5.05E-02	7.00E-01	2.33E-05	1.69E-05
Chloroform	Organic	6.83E-03	1	4.98E-01	2.87E-02	1.19E+00	1.33E-05	1.01E-05
Tetrachloroethene	Organic	3.34E-02	1	9.06E-01	1.66E-01	2.18E+00	8.80E-05	6.70E-05
Trichloroethene - Mutagenic	Organic	1.16E-02	1	5.81E-01	5.13E-02	1.39E+00	2.45E-05	1.87E-05
Trichloroethene - Nonmutagenic	Organic	1.16E-02	1	5.81E-01	5.13E-02	1.39E+00	2.45E-05	1.87E-05
Heptachlor Epoxide	Organic	2.03E-02	1	1.59E+01	1.54E-01	3.82E+01	2.23E-04	1.70E-04
Arsenic	Inorganic	1.00E-03	1	NA	NA	NA	1.00E-06	1.00E-06

CHEMICAL	Cancer Slope Factor			Reference Dose			Volatile
	Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Inhalation $(ug/m^3)^{-1}$	Oral (mg/kg/day)	Dermal (mg/kg/day)	Inhalation (mg/m^3)	Yes or No
Benzene	5.50E-02	5.50E-02	7.80E-06	4.00E-03	4.00E-03	3.00E-02	Yes
Chloroform	3.1E-02	3.1E-02	2.3E-05	1.00E-02	1.00E-02	9.80E-02	Yes
Tetrachloroethene	2.10E-03	2.10E-03	2.60E-07	6.00E-03	6.00E-03	4.00E-02	Yes
Trichloroethene - Mutagenic	9.3E-03	9.3E-03	1.0E-06	NA	NA	NA	Yes
Trichloroethene - Nonmutagenic	3.7E-02	3.7E-02	3.1E-06	5.00E-04	5.00E-04	2.00E-03	Yes
Heptachlor Epoxide	9.1E+00	9.1E+00	2.6E-03	1.30E-05	1.30E-05	NA	No
Arsenic	1.50E+00	1.50E+00	4.30E-03	3.00E-04	3.00E-04	1.50E-05	No

CHEMICAL	Carcinogenic Intakes			Noncarcinogenic Intakes		
	Ingestion (L/kg/day)	Dermal (L/kg/day)	Inhalation (L/m^3)	Ingestion (L/kg/day)	Dermal (L/kg/day)	Inhalation (L/m^3)
Benzene	6.11E-02	7.11E-03	0.00E+00	9.59E-02	9.82E-03	0.00E+00
Chloroform	6.11E-02	4.14E-03	0.00E+00	9.59E-02	5.62E-03	0.00E+00
Tetrachloroethene	6.11E-02	2.73E-02	0.00E+00	9.59E-02	3.71E-02	0.00E+00
Trichloroethene - Mutagenic	6.11E-02	7.62E-03	0.00E+00	9.59E-02	1.03E-02	0.00E+00
Trichloroethene - Nonmutagenic	1.76E-02	2.47E-03	0.00E+00	9.59E-02	1.03E-02	0.00E+00
Heptachlor Epoxide	1.76E-02	2.24E-02	0.00E+00	9.59E-02	9.42E-02	0.00E+00
Arsenic	1.76E-02	1.21E-04	0.00E+00	9.59E-02	4.22E-04	0.00E+00

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH GROUNDWATER (PAGE THREE OF THREE)

SITE NAME: NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
LOCATION: BUILDING 82
EXPOSURE SCENARIO: LIFELONG RESIDENT
MEDIA: GROUNDWATER
DATE: MAY 21, 2012

CHEMICAL	Groundwater Concentration	
	Carcinogenic (ug/L)	Noncarcinogenic[(1)] (ug/L)
Benzene	0.27	37.8
Chloroform	0.49	99
Tetrachloroethene	5.4	45.1
Trichloroethene - Mutagenic	1.6	NA
Trichloroethene - Nonmutagenic	1.3	4.7
Heptachlor Epoxide	0.0027	0.07
Arsenic	0.038	3.1

TCE = 1/1/Mutagenic + 1/nonmutagenic)
= 1/(1/1.6 + 1/1.3)
= 0.72

1 - Noncarcinogenic PRG based on the child resident receptor.

DATA ENTRY SHEET - TRICHLOROETHENE - NON-MUTAGENIC

GW-SCREEN
Version 3.1; 02/04

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	9.00E+00	Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	244	SI	9	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)		ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI	OR		SI	1.35	0.489	0.167

Lookup Soil

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET - TRICHLOROETHENE - NON-MUTAGENIC

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	3.1E-06	2.0E-03

END

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
229	0.322	0.267	6.73E-09	0.830	5.59E-09	163.04	0.489	0.107	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,569	4.52E-03	1.95E-01	1.75E-04	7.59E-03	2.03E-04	2.83E-04

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m^3)	Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
229	15	1.76E+03	0.10	8.33E+01	7.59E-03	4.00E+02	1.66E+119	7.18E-05	1.26E-01	3.1E-06	2.0E-03

RESULTS SHEET - TRICHLOROETHENE - NON-MUTAGENIC

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.6E-07	6.1E-02

MESSAGE SUMMARY BELOW:

END

]

Soil Properties Lookup Table

SCS Soil Type	K_s (cm/h)	α_1 (1/cm)	N (unitless)	M (unitless)	n (cm^3/cm^3)	θ_r (cm^3/cm^3)	Mean Grain Diameter (cm)	Bulk Density (g/cm^3)	θ_w (cm^3/cm^3)	SCS Soil Name
C	0.61	0.01496	1.253	0.2019	0.459	0.098	0.0092	1.43	0.215	Clay
CL	0.34	0.01581	1.416	0.2938	0.442	0.079	0.016	1.48	0.168	Clay Loam
L	0.50	0.01112	1.472	0.3207	0.399	0.061	0.020	1.59	0.148	Loam
LS	4.38	0.03475	1.746	0.4273	0.390	0.049	0.040	1.62	0.076	Loamy Sand
S	26.78	0.03524	3.177	0.6852	0.375	0.053	0.044	1.66	0.054	Sand
SC	0.47	0.03342	1.208	0.1722	0.385	0.117	0.025	1.63	0.197	Sandy Clay
SCL	0.55	0.02109	1.330	0.2481	0.384	0.063	0.029	1.63	0.146	Sandy Clay Loam
SI	1.82	0.00658	1.679	0.4044	0.489	0.050	0.0046	1.35	0.167	Silt
SIC	0.40	0.01622	1.321	0.2430	0.481	0.111	0.0039	1.38	0.216	Silty Clay
SICL	0.46	0.00839	1.521	0.3425	0.482	0.090	0.0056	1.37	0.198	Silty Clay Loam
SIL	0.76	0.00506	1.663	0.3987	0.439	0.065	0.011	1.49	0.180	Silt Loam
SL	1.60	0.02667	1.449	0.3099	0.387	0.039	0.030	1.62	0.103	Sandy Loam

Chemical Properties Lookup Table

CAS No.	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)	URF extrapolated (X)	RfC extrapolated (X)
56235	Carbon tetrachloride	1.74E+02	7.80E-02	8.80E-06	7.93E+02	1.24E+00	3.03E-02	25	349.90	556.60	7,127	1.5E-05	0.0E+00		
57749	Chlordane	1.20E+05	1.18E-02	4.37E-06	5.60E-02	1.99E-03	4.85E-05	25	624.24	885.73	14,000	1.0E-04	7.0E-04		
58899	gamma-HCH (Lindane)	1.07E+03	1.42E-02	7.34E-06	7.30E+00	5.73E-04	1.40E-05	25	596.55	839.36	15,000	3.7E-04	1.1E-03	X	X
60297	Ethyl ether	5.73E+00	7.82E-02	8.61E-06	5.68E+04	1.35E+00	3.29E-02	25	307.50	466.74	6,338	0.0E+00	7.0E-01		X
60571	Dieldrin	2.14E+04	1.25E-02	4.74E-06	1.95E-01	6.18E-04	1.51E-05	25	613.32	842.25	17,000	4.6E-03	1.8E-04		X
67641	Acetone	5.75E-01	1.24E-01	1.14E-05	1.00E+06	1.59E-03	3.87E-05	25	329.20	508.10	6,955	0.0E+00	3.5E-01		X
67663	Chloroform	3.98E+01	1.04E-01	1.00E-05	7.92E+03	1.50E-01	3.66E-03	25	334.32	536.40	6,988	2.3E-05	0.0E+00		
67721	Hexachloroethane	1.78E+03	2.50E-03	6.80E-06	5.00E+01	1.59E-01	3.88E-03	25	458.00	695.00	9,510	4.0E-06	3.5E-03		X
71432	Benzene	5.89E+01	8.80E-02	9.80E-06	1.79E+03	2.27E-01	5.54E-03	25	353.24	562.16	7,342	7.8E-06	3.0E-02		
71556	1,1,1-Trichloroethane	1.10E+02	7.80E-02	8.80E-06	1.33E+03	7.03E-01	1.72E-02	25	347.24	545.00	7,136	0.0E+00	2.2E+00		
72435	Methoxychlor	9.77E+04	1.56E-02	4.46E-06	1.00E-01	6.46E-04	1.58E-05	25	651.02	848.49	16,000	0.0E+00	1.8E-02		X
72559	DDE	4.47E+06	1.44E-02	5.87E-06	1.20E-01	8.59E-04	2.09E-05	25	636.44	860.38	15,000	9.7E-05	0.0E+00	X	
74839	Methyl bromide	1.05E+01	7.28E-02	1.21E-05	1.52E+04	2.55E-01	6.22E-03	25	276.71	467.00	5,714	0.0E+00	5.0E-03		
74873	Methyl chloride (chloromethane)	2.12E+00	1.26E-01	6.50E-06	5.33E+03	3.61E-01	8.80E-03	25	249.00	416.25	5,115	1.0E-06	9.0E-02		
74908	Hydrogen cyanide	3.80E+00	1.93E-01	2.10E-05	1.00E+06	5.44E-03	1.33E-04	25	299.00	456.70	6,676	0.0E+00	3.0E-03		
74953	Methylene bromide	1.26E+01	4.30E-02	8.44E-06	1.19E+04	3.52E-02	8.59E-04	25	370.00	583.00	7,868	0.0E+00	3.5E-02		X
75003	Chloroethane (ethyl chloride)	4.40E+00	2.71E-01	1.15E-05	5.68E+03	3.61E-01	8.80E-03	25	285.30	460.40	5,879	8.3E-07	1.0E+01	X	
75014	Vinyl chloride (chloroethene)	1.86E+01	1.06E-01	1.23E-05	8.80E+03	1.10E+00	2.69E-02	25	259.25	432.00	5,250	8.8E-06	1.0E-01		
75058	Acetonitrile	4.20E+00	1.28E-01	1.66E-05	1.00E+06	1.42E-03	3.45E-05	25	354.60	545.50	7,110	0.0E+00	6.0E-02		
75070	Acetaldehyde	1.06E+00	1.24E-01	1.41E-05	1.00E+06	3.23E-03	7.87E-05	25	293.10	466.00	6,157	2.2E-06	9.0E-03		
75092	Methylene chloride	1.17E+01	1.01E-01	1.17E-05	1.30E+04	8.96E-02	2.18E-03	25	313.00	510.00	6,706	4.7E-07	3.0E+00		
75150	Carbon disulfide	4.57E+01	1.04E-01	1.00E-05	1.19E+03	1.24E+00	3.02E-02	25	319.00	552.00	6,391	0.0E+00	7.0E-01		
75218	Ethylene oxide	1.33E+00	1.04E-01	1.45E-05	3.04E+05	2.27E-02	5.54E-04	25	283.60	469.00	6,104	1.0E-04	0.0E+00		
75252	Bromoform	8.71E+01	1.49E-02	1.03E-05	3.10E+03	2.41E-02	5.88E-04	25	422.35	696.00	9,479	1.1E-06	7.0E-02		X
75274	Bromodichloromethane	5.50E+01	2.98E-02	1.06E-05	6.74E+03	6.54E-02	1.60E-03	25	363.15	585.85	7,800	1.8E-05	7.0E-02	X	X
75296	2-Chloropropane	9.14E+00	8.88E-02	1.01E-05	3.73E+03	5.93E-01	1.45E-02	25	308.70	485.00	6,286	0.0E+00	1.0E-01		
75343	1,1-Dichloroethane	3.16E+01	7.42E-02	1.05E-05	5.06E+03	2.30E-01	5.61E-03	25	330.55	523.00	6,895	0.0E+00	5.0E-01		
75354	1,1-Dichloroethylene	5.89E+01	9.00E-02	1.04E-05	2.25E+03	1.07E+00	2.60E-02	25	304.75	576.05	6,247	0.0E+00	2.0E-01		
75456	Chlorodifluoromethane	4.79E+01	1.01E-01	1.28E-05	2.00E+00	1.10E+00	2.70E-02	25	232.40	369.30	4,836	0.0E+00	5.0E+01		
75694	Trichlorofluoromethane	4.97E+02	8.70E-02	9.70E-06	1.10E+03	3.97E+00	9.68E-02	25	296.70	471.00	5,999	0.0E+00	7.0E-01		
75718	Dichlorodifluoromethane	4.57E+02	6.65E-02	9.92E-06	2.80E+02	1.40E+01	3.42E-01	25	243.20	384.95	9,421	0.0E+00	2.0E-01		
76131	1,1,2-Trichloro-1,2,2-trifluoroethar	1.11E+04	7.80E-02	8.20E-06	1.70E+02	1.97E+01	4.80E-01	25	320.70	487.30	6,463	0.0E+00	3.0E+01		
76448	Heptachlor	1.41E+06	1.12E-02	5.69E-06	1.80E-01	6.05E+01	1.48E+00	25	603.69	846.31	13,000	1.3E-03	1.8E-03		X
77474	Hexachlorocyclopentadiene	2.00E+05	1.61E-02	7.21E-06	1.80E+00	1.10E+00	2.69E-02	25	512.15	746.00	10,931	0.0E+00	2.0E-04		
78831	Isobutanol	2.59E+00	8.60E-02	9.30E-06	8.50E+04	4.83E-04	1.18E-05	25	381.04	547.78	10,936	0.0E+00	1.1E+00		X
78875	1,2-Dichloropropane	4.37E+01	7.82E-02	8.73E-06	2.80E+03	1.15E-01	2.79E-03	25	369.52	572.00	7,590	1.9E-05	4.0E-03	X	
78933	Methylethylketone (2-butanone)	2.30E+00	8.08E-02	9.80E-06	2.23E+05	2.29E-03	5.58E-05	25	352.50	536.78	7,481	0.0E+00	5.0E+00		
79005	1,1,2-Trichloroethane	5.01E+01	7.80E-02	8.80E-06	4.42E+03	3.73E-02	9.11E-04	25	386.15	602.00	8,322	1.6E-05	1.4E-02		X
79016	Trichloroethylene	1.66E+02	7.90E-02	9.10E-06	1.47E+03	4.21E-01	1.03E-02	25	360.36	544.20	7,505	3.1E-06	2.0E-03		
79209	Methyl acetate	3.26E+00	1.04E-01	1.00E-05	2.00E+03	4.84E-03	1.18E-04	25	329.80	506.70	7,260	0.0E+00	3.5E+00		X
79345	1,1,2,2-Tetrachloroethane	9.33E+01	7.10E-02	7.90E-06	2.96E+03	1.41E-02	3.44E-04	25	419.60	661.15	8,996	5.8E-05	2.1E-01		X
79469	2-Nitropropane	1.17E+01	9.23E-02	1.01E-05	1.70E+04	5.03E-03	1.23E-04	25	393.20	594.00	8,383	2.7E-03	2.0E-02		
80626	Methylmethacrylate	6.98E+00	7.70E-02	8.60E-06	1.50E+04	1.38E-02	3.36E-04	25	373.50	567.00	8,975	0.0E+00	7.0E-01		
83329	Acenaphthene	7.08E+03	4.21E-02	7.69E-06	3.57E+00	6.34E-03	1.55E-04	25	550.54	803.15	12,155	0.0E+00	2.1E-01		X
86737	Fluorene	1.38E+04	3.63E-02	7.88E-06	1.98E+00	2.60E-03	6.34E-05	25	570.44	870.00	12,666	0.0E+00	1.4E-01		X
87683	Hexachloro-1,3-butadiene	5.37E+04	5.61E-02	6.16E-06	3.20E+00	3.33E-01	8.13E-03	25	486.15	738.00	10,206	2.2E-05	7.0E-04		X

88722	o-Nitrotoluene	3.24E+02	5.87E-02	8.67E-06	6.50E+02	5.11E-04	1.25E-05	25	495.00	720.00	12,239	0.0E+00	3.5E-02		X
91203	Naphthalene	2.00E+03	5.90E-02	7.50E-06	3.10E+01	1.98E-02	4.82E-04	25	491.14	748.40	10,373	0.0E+00	3.0E-03		
91576	2-Methylnaphthalene	2.81E+03	5.22E-02	7.75E-06	2.46E+01	2.12E-02	5.17E-04	25	514.26	761.00	12,600	0.0E+00	7.0E-02		X
92524	Biphenyl	4.38E+03	4.04E-02	8.15E-06	7.45E+00	1.23E-02	2.99E-04	25	529.10	789.00	10,890	0.0E+00	1.8E-01		X
95476	o-Xylene	3.63E+02	8.70E-02	1.00E-05	1.78E+02	2.12E-01	5.18E-03	25	417.60	630.30	8,661	0.0E+00	1.0E-01		
95501	1,2-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	1.56E+02	7.77E-02	1.90E-03	25	453.57	705.00	9,700	0.0E+00	2.0E-01		
95578	2-Chlorophenol	3.88E+02	5.01E-02	9.46E-06	2.20E+04	1.60E-02	3.90E-04	25	447.53	675.00	9,572	0.0E+00	1.8E-02		X
95636	1,2,4-Trimethylbenzene	1.35E+03	6.06E-02	7.92E-06	5.70E+01	2.52E-01	6.14E-03	25	442.30	649.17	9,369	0.0E+00	6.0E-03		
96184	1,2,3-Trichloropropane	2.20E+01	7.10E-02	7.90E-06	1.75E+03	1.67E-02	4.08E-04	25	430.00	652.00	9,171	5.7E-04	4.9E-03	X	
96333	Methyl acrylate	4.53E+00	9.76E-02	1.02E-05	6.00E+04	7.68E-03	1.87E-04	25	353.70	536.00	7,749	0.0E+00	1.1E-01		X
97632	Ethylmethacrylate	2.95E+01	6.53E-02	8.37E-06	3.67E+03	3.44E-02	8.40E-04	25	390.00	571.00	10,957	0.0E+00	3.2E-01		X
98066	tert-Butylbenzene	7.71E+02	5.65E-02	8.02E-06	2.95E+01	4.87E-01	1.19E-02	25	442.10	1220.00	8,980	0.0E+00	1.4E-01		X
98828	Cumene	4.89E+02	6.50E-02	7.10E-06	6.13E+01	4.74E+01	1.46E-02	25	425.56	631.10	10,335	0.0E+00	4.0E-01		
98862	Acetophenone	5.77E+01	6.00E-02	8.73E-06	6.13E+03	4.38E-04	1.07E-05	25	475.00	709.50	11,732	0.0E+00	3.5E-01		X
98953	Nitrobenzene	6.46E+01	7.60E-02	8.60E-06	2.09E+03	9.82E-04	2.39E-05	25	483.95	719.00	10,566	0.0E+00	2.0E-03		
100414	Ethylbenzene	3.63E+02	7.50E-02	7.80E-06	1.69E+02	3.22E-01	7.86E-03	25	409.34	617.20	8,501	0.0E+00	1.0E+00		
100425	Styrene	7.76E+02	7.10E-02	8.00E-06	3.10E+02	1.12E-01	2.74E-03	25	418.31	636.00	8,737	0.0E+00	1.0E+00		
100447	Benzylchloride	6.14E+01	7.50E-02	7.80E-06	5.25E+02	1.70E-02	4.14E-04	25	452.00	685.00	8,773	4.9E-05	0.0E+00	X	
100527	Benzaldehyde	4.59E+01	7.21E-02	9.07E-06	3.30E+03	9.73E-04	2.37E-05	25	452.00	695.00	11,658	0.0E+00	3.5E-01		X
103651	n-Propylbenzene	5.62E+02	6.01E-02	7.83E-06	6.00E+01	4.37E-01	1.07E-02	25	432.20	630.00	9,123	0.0E+00	1.4E-01		X
104518	n-Butylbenzene	1.11E+03	5.70E-02	8.12E-06	2.00E+00	5.38E-01	1.31E-02	25	456.46	660.50	9,290	0.0E+00	1.4E-01		X
106423	p-Xylene	3.89E+02	7.69E-02	8.44E-06	1.85E+02	3.13E-01	7.64E-03	25	411.52	616.20	8,525	0.0E+00	1.0E-01		
106467	1,4-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	7.90E+01	9.82E-02	2.39E-03	25	447.21	684.75	9,271	0.0E+00	8.0E-01		
106934	1,2-Dibromoethane (ethylene dibr	2.50E+01	2.17E-02	1.19E-05	4.18E+03	3.04E-02	7.41E-04	25	404.60	583.00	8,310	2.2E-04	2.0E-04		
106990	1,3-Butadiene	1.91E+01	2.49E-01	1.08E-05	7.35E+02	3.01E+00	7.34E-02	25	268.60	425.00	5,370	3.0E-02	2.0E-03		
107028	Acrolein	2.76E+00	1.05E-01	1.22E-05	2.13E+05	4.99E-03	1.22E-04	25	325.60	506.00	6,731	0.0E+00	2.0E-05		
107062	1,2-Dichloroethane	1.74E+01	1.04E-01	9.90E-06	8.52E+03	4.00E-02	9.77E-04	25	356.65	561.00	7,643	2.6E-05	0.0E+00		
107131	Acrylonitrile	5.90E+00	1.22E-01	1.34E-05	7.40E+04	4.21E-03	1.03E-04	25	350.30	519.00	7,786	6.8E-05	2.0E-03		
108054	Vinyl acetate	5.25E+00	8.50E-02	9.20E-06	2.00E+04	2.09E-02	5.10E-04	25	345.65	519.13	7,800	0.0E+00	2.0E-01		
108101	Methylisobutylketone (4-methyl-2-	9.06E+00	7.50E-02	7.80E-06	1.90E+04	5.64E-03	1.38E-04	25	389.50	571.00	8,243	0.0E+00	3.0E+00		
108383	m-Xylene	4.07E+02	7.00E-02	7.80E-06	1.61E+02	3.00E-01	7.32E-03	25	412.27	617.05	8,523	0.0E+00	1.0E-01		
108678	1,3,5-Trimethylbenzene	1.35E+03	6.02E-02	8.67E-06	2.00E+00	2.41E-01	5.87E-03	25	437.89	637.25	9,321	0.0E+00	6.0E-03		
108872	Methylcyclohexane	7.85E+01	7.35E-02	8.52E-06	1.40E+01	4.22E+00	1.03E-01	25	373.90	572.20	7,474	0.0E+00	3.0E+00		
108883	Toluene	1.82E+02	8.70E-02	8.60E-06	5.26E+02	2.72E-01	6.62E-03	25	383.78	591.79	7,930	0.0E+00	4.0E-01		
108907	Chlorobenzene	2.19E+02	7.30E-02	8.70E-06	4.72E+02	1.51E-01	3.69E-03	25	404.87	632.40	8,410	0.0E+00	6.0E-02		
109693	1-Chlorobutane	1.72E+01	8.26E-02	1.00E-05	1.10E+03	6.93E-01	1.69E-02	25	351.60	542.00	7,263	0.0E+00	1.4E+00		X
110009	Furan	1.86E+01	1.04E-01	1.22E-05	1.00E+04	2.21E-01	5.39E-03	25	304.60	490.20	6,477	0.0E+00	3.5E-03		X
110543	Hexane	4.34E+01	2.00E-01	7.77E-06	1.24E+01	6.82E+01	1.66E+00	25	341.70	508.00	6,895	0.0E+00	2.0E-01		
111444	Bis(2-chloroethyl)ether	1.55E+01	6.92E-02	7.53E-06	1.72E+04	7.36E-04	1.80E-05	25	451.15	659.79	10,803	3.3E-04	0.0E+00		
115297	Endosulfan	2.14E+03	1.15E-02	4.55E-06	5.10E-01	4.58E-04	1.12E-05	25	674.43	942.94	14,000	0.0E+00	2.1E-02		X
118741	Hexachlorobenzene	5.50E+04	5.42E-02	5.91E-06	5.00E-03	5.40E-02	1.32E-03	25	582.55	825.00	14,447	4.6E-04	2.8E-03		X
120821	1,2,4-Trichlorobenzene	1.78E+03	3.00E-02	8.23E-06	4.88E+01	5.81E-02	1.42E-03	25	486.15	725.00	10,471	0.0E+00	4.0E-03		
123739	Crotonaldehyde (2-butenal)	4.82E+00	9.56E-02	1.07E-05	3.69E+04	7.99E-04	1.95E-05	25	375.20	568.00	9	5.4E-04	0.0E+00	X	
124481	Chlorodibromomethane	6.31E+01	1.96E-02	1.05E-05	2.60E+03	3.20E-02	7.81E-04	25	416.14	678.20	5,900	2.4E-05	7.0E-02	X	X
126987	Methacrylonitrile	3.58E+01	1.12E-01	1.32E-05	2.54E+04	1.01E-02	2.46E-04	25	363.30	554.00	7,600	0.0E+00	7.0E-04		
126998	2-Chloro-1,3-butadiene (chloropre	6.73E+01	8.58E-02	1.03E-05	2.12E+03	4.91E-01	1.20E-02	25	332.40	525.00	8,075	0.0E+00	7.0E-03		
127184	Tetrachloroethylene	1.55E+02	7.20E-02	8.20E-06	2.00E+02	7.53E-01	1.84E-02	25	394.40	620.20	8,288	5.9E-06	6.0E-01		
129000	Pyrene	1.05E+05	2.72E-02	7.24E-06	1.35E+00	4.50E-04	1.10E-05	25	667.95	936	14370	0.0E+00	1.1E-01		X
132649	Dibenzofuran	5.15E+03	2.38E-02	6.00E-06	3.10E+00	5.15E-04	1.26E-05	25	560	824	66400	0.0E+00	1.4E-02		X
135988	sec-Butylbenzene	9.66E+02	5.70E-02	8.12E-06	3.94E+00	5.68E-01	1.39E-02	25	446.5	679	88730	0.0E+00	1.4E-01		X
141786	Ethylacetate	6.44E+00	7.32E-02	9.70E-06	8.03E+04	5.64E-03	1.38E-04	25	350.26	523.3	7633.66	0.0E+00	3.2E+00		X
156592	cis-1,2-Dichloroethylene	3.55E+01	7.36E-02	1.13E-05	3.50E+03	1.67E-01	4.07E-03	25	333.65	544	7192	0.0E+00	3.5E-02		X
156605	trans-1,2-Dichloroethylene	5.25E+01	7.07E-02	1.19E-05	6.30E+03	3.84E-01	9.36E-03	25	320.85	516.5	6717	0.0E+00	7.0E-02		X
205992	Benzo(b)fluoranthene	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.54E-03	1.11E-04	25	715.9	969.27	17000	2.1E-04	0.0E+00	X	
218019	Chrysene	3.98E+05	2.48E-02	6.21E-06	6.30E-03	3.87E-03	9.44E-05	25	714.15	979	16455	2.1E-06	0.0E+00	X	
309002	Aldrin	2.45E+06	1.32E-02	4.86E-06	1.70E-02	6.95E-03	1.70E-04	25	603.01	839.37	15000	4.9E-03	1.1E-04		X
319846	alpha-HCH (alpha-BHC)	1.23E+03	1.42E-02	7.34E-06	2.00E+00	4.34E-04	1.06E-05	25	596.55	839.36	15000	1.8E-03	0.0E+00		
541731	1,3-Dichlorobenzene	1.98E+03	6.92E-02	7.86E-06	1.34E+02	1.27E-01	3.09E-03	25	446	684	9230.18	0.0E+00	1.1E-01		X
542756	1,3-Dichloropropene	4.57E+01	6.26E-02	1.00E-05	2.80E+03	7.24E-01	1.77E-02	25	381.15	587.38	7900	4.0E-06	2.0E-02		
630206	1,1,1,2-Tetrachloroethane	1.16E+02	7.10E-02	7.90E-06	1.10E+03	9.90E-02	2.41E-03	25	403.5	624	9768.282525	7.4E-06	1.1E-01		X
1634044	MTBE	7.26E+00	1.02E-01	1.05E-05	5.10E+04	2.56E-02	6.23E-04	25	328.3	497.1	6677.66	0.0E+00	3.0E+00		
7439976	Mercury (elemental)	5.20E+01	3.07E-02	6.30E-06	2.00E+01	4.40E-01	1.07E-02	25	629.88	1750	14127	0.0E+00	3.0E-04		

DATA ENTRY SHEET - TRICHLOROETHENE

GW-SCREEN
Version 3.1; 02/04

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	9.00E+00	Trichloroethylene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
15	244	SI	9	5

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vandose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone SCS soil type (Lookup Soil)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
SI			SI	1.35	0.489	0.167

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	76	350

Used to calculate risk-based groundwater concentration.

CHEMICAL PROPERTIES SHEET - TRICHLOROETHENE - MUTAGENIC

ABC

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.0E-06	0.0E+00

END

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
229	0.322	0.267	6.73E-09	0.830	5.59E-09	163.04	0.489	0.107	0.382	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)
1.69E+04	1.00E+06	4.00E-04	15	8,569	4.52E-03	1.95E-01	1.75E-04	7.59E-03	2.03E-04	2.83E-04

Diffusion path length, L_d (cm)	Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
229	15	1.76E+03	0.10	8.33E+01	7.59E-03	4.00E+02	1.66E+119	7.18E-05	1.26E-01	1.0E-06	NA

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.3E-07	NA

MESSAGE SUMMARY BELOW:

END

]

VLOOKUP TABLES

Soil Properties Lookup Table

SCS Soil Type	K_s (cm/h)	α_1 (1/cm)	N (unitless)	M (unitless)	n (cm^3/cm^3)	θ_r (cm^3/cm^3)	Mean Grain Diameter (cm)	Bulk Density (g/cm^3)	θ_w (cm^3/cm^3)	SCS Soil Name
C	0.61	0.01496	1.253	0.2019	0.459	0.098	0.0092	1.43	0.215	Clay
CL	0.34	0.01581	1.416	0.2938	0.442	0.079	0.016	1.48	0.168	Clay Loam
L	0.50	0.01112	1.472	0.3207	0.399	0.061	0.020	1.59	0.148	Loam
LS	4.38	0.03475	1.746	0.4273	0.390	0.049	0.040	1.62	0.076	Loamy Sand
S	26.78	0.03524	3.177	0.6852	0.375	0.053	0.044	1.66	0.054	Sand
SC	0.47	0.03342	1.208	0.1722	0.385	0.117	0.025	1.63	0.197	Sandy Clay
SCL	0.55	0.02109	1.330	0.2481	0.384	0.063	0.029	1.63	0.146	Sandy Clay Loam
SI	1.82	0.00658	1.679	0.4044	0.489	0.050	0.0046	1.35	0.167	Silt
SIC	0.40	0.01622	1.321	0.2430	0.481	0.111	0.0039	1.38	0.216	Silty Clay
SICL	0.46	0.00839	1.521	0.3425	0.482	0.090	0.0056	1.37	0.198	Silty Clay Loam
SIL	0.76	0.00506	1.663	0.3987	0.439	0.065	0.011	1.49	0.180	Silt Loam
SL	1.60	0.02667	1.449	0.3099	0.387	0.039	0.030	1.62	0.103	Sandy Loam

Chemical Properties Lookup Table

CAS No.	Chemical	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Pure component water solubility, S (mg/L)	Henry's law constant H' (unitless)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	URF extrapolated (X)	RfC extrapolated (X)
56235	Carbon tetrachloride	1.74E+02	7.80E-02	8.80E-06	7.93E+02	1.24E+00	3.03E-02	25	349.90	556.60	7,127	1.5E-05	0.0E+00		
57749	Chlordane	1.20E+05	1.18E-02	4.37E-06	5.60E-02	1.99E-03	4.85E-05	25	624.24	885.73	14,000	1.0E-04	7.0E-04		
58899	gamma-HCH (Lindane)	1.07E+03	1.42E-02	7.34E-06	7.30E+00	5.73E-04	1.40E-05	25	596.55	839.36	15,000	3.7E-04	1.1E-03	X	X
60297	Ethyl ether	5.73E+00	7.82E-02	8.61E-06	5.68E+04	1.35E+00	3.29E-02	25	307.50	466.74	6,338	0.0E+00	7.0E-01		X
60571	Dieldrin	2.14E+04	1.25E-02	4.74E-06	1.95E-01	6.18E-04	1.51E-05	25	613.32	842.25	17,000	4.6E-03	1.8E-04		X
67641	Acetone	5.75E-01	1.24E-01	1.14E-05	1.00E+06	1.59E-03	3.87E-05	25	329.20	508.10	6,955	0.0E+00	3.5E-01		X
67663	Chloroform	3.98E+01	1.04E-01	1.00E-05	7.92E+03	1.50E-01	3.66E-03	25	334.32	536.40	6,988	2.3E-05	0.0E+00		
67721	Hexachloroethane	1.78E+03	2.50E-03	6.80E-06	5.00E+01	1.59E-01	3.88E-03	25	458.00	695.00	9,510	4.0E-06	3.5E-03		X
71432	Benzene	5.89E+01	8.80E-02	9.80E-06	1.79E+03	2.27E-01	5.54E-03	25	353.24	562.16	7,342	7.8E-06	3.0E-02		
71556	1,1,1-Trichloroethane	1.10E+02	7.80E-02	8.80E-06	1.33E+03	7.03E-01	1.72E-02	25	347.24	545.00	7,136	0.0E+00	2.2E+00		
72435	Methoxychlor	9.77E+04	1.56E-02	4.46E-06	1.00E-01	6.46E-04	1.58E-05	25	651.02	848.49	16,000	0.0E+00	1.8E-02		X
72559	DDE	4.47E+06	1.44E-02	5.87E-06	1.20E-01	8.59E-04	2.09E-05	25	636.44	860.38	15,000	9.7E-05	0.0E+00	X	
74839	Methyl bromide	1.05E+01	7.28E-02	1.21E-05	1.52E+04	2.55E-01	6.22E-03	25	276.71	467.00	5,714	0.0E+00	5.0E-03		
74873	Methyl chloride (chloromethane)	2.12E+00	1.26E-01	6.50E-06	5.33E+03	3.61E-01	8.80E-03	25	249.00	416.25	5,115	1.0E-06	9.0E-02		
74908	Hydrogen cyanide	3.80E+00	1.93E-01	2.10E-05	1.00E+06	5.44E-03	1.33E-04	25	299.00	456.70	6,676	0.0E+00	3.0E-03		
74953	Methylene bromide	1.26E+01	4.30E-02	8.44E-06	1.19E+04	3.52E-02	8.59E-04	25	370.00	583.00	7,868	0.0E+00	3.5E-02		X
75003	Chloroethane (ethyl chloride)	4.40E+00	2.71E-01	1.15E-05	5.68E+03	3.61E-01	8.80E-03	25	285.30	460.40	5,879	8.3E-07	1.0E+01	X	
75014	Vinyl chloride (chloroethene)	1.86E+01	1.06E-01	1.23E-05	8.80E+03	1.10E+00	2.69E-02	25	259.25	432.00	5,250	8.8E-06	1.0E-01		
75058	Acetonitrile	4.20E+00	1.28E-01	1.66E-05	1.00E+06	1.42E-03	3.45E-05	25	354.60	545.50	7,110	0.0E+00	6.0E-02		
75070	Acetaldehyde	1.06E+00	1.24E-01	1.41E-05	1.00E+06	3.23E-03	7.87E-05	25	293.10	466.00	6,157	2.2E-06	9.0E-03		
75092	Methylene chloride	1.17E+01	1.01E-01	1.17E-05	1.30E+04	8.96E-02	2.18E-03	25	313.00	510.00	6,706	4.7E-07	3.0E+00		
75150	Carbon disulfide	4.57E+01	1.04E-01	1.00E-05	1.19E+03	1.24E+00	3.02E-02	25	319.00	552.00	6,391	0.0E+00	7.0E-01		
75218	Ethylene oxide	1.33E+00	1.04E-01	1.45E-05	3.04E+05	2.27E-02	5.54E-04	25	283.60	469.00	6,104	1.0E-04	0.0E+00		
75252	Bromoform	8.71E+01	1.49E-02	1.03E-05	3.10E+03	2.41E-02	5.88E-04	25	422.35	696.00	9,479	1.1E-06	7.0E-02		X
75274	Bromodichloromethane	5.50E+01	2.98E-02	1.06E-05	6.74E+03	6.54E-02	1.60E-03	25	363.15	585.85	7,800	1.8E-05	7.0E-02	X	X
75296	2-Chloropropane	9.14E+00	8.88E-02	1.01E-05	3.73E+03	5.93E-01	1.45E-02	25	308.70	485.00	6,286	0.0E+00	1.0E-01		
75343	1,1-Dichloroethane	3.16E+01	7.42E-02	1.05E-05	5.06E+03	2.30E-01	5.61E-03	25	330.55	523.00	6,895	0.0E+00	5.0E-01		
75354	1,1-Dichloroethylene	5.89E+01	9.00E-02	1.04E-05	2.25E+03	1.07E+00	2.60E-02	25	304.75	576.05	6,247	0.0E+00	2.0E-01		
75456	Chlorodifluoromethane	4.79E+01	1.01E-01	1.28E-05	2.00E+00	1.10E+00	2.70E-02	25	232.40	369.30	4,836	0.0E+00	5.0E+01		
75694	Trichlorofluoromethane	4.97E+02	8.70E-02	9.70E-06	1.10E+03	3.97E+00	9.68E-02	25	296.70	471.00	5,999	0.0E+00	7.0E-01		
75718	Dichlorodifluoromethane	4.57E+02	6.65E-02	9.92E-06	2.80E+02	1.40E+01	3.42E-01	25	243.20	384.95	9,421	0.0E+00	2.0E-01		
76131	1,1,2-Trichloro-1,2,2-trifluoroethar	1.11E+04	7.80E-02	8.20E-06	1.70E+02	1.97E+01	4.80E-01	25	320.70	487.30	6,463	0.0E+00	3.0E+01		
76448	Heptachlor	1.41E+06	1.12E-02	5.69E-06	1.80E-01	6.05E+01	1.48E+00	25	603.69	846.31	13,000	1.3E-03	1.8E-03		X
77474	Hexachlorocyclopentadiene	2.00E+05	1.61E-02	7.21E-06	1.80E+00	1.10E+00	2.69E-02	25	512.15	746.00	10,931	0.0E+00	2.0E-04		
78831	Isobutanol	2.59E+00	8.60E-02	9.30E-06	8.50E+04	4.83E-04	1.18E-05	25	381.04	547.78	10,936	0.0E+00	1.1E+00		X
78875	1,2-Dichloropropane	4.37E+01	7.82E-02	8.73E-06	2.80E+03	1.15E-01	2.79E-03	25	369.52	572.00	7,590	1.9E-05	4.0E-03	X	
78933	Methylethylketone (2-butanone)	2.30E+00	8.08E-02	9.80E-06	2.23E+05	2.29E-03	5.58E-05	25	352.50	536.78	7,481	0.0E+00	5.0E+00		
79005	1,1,2-Trichloroethane	5.01E+01	7.80E-02	8.80E-06	4.42E+03	3.73E-02	9.11E-04	25	386.15	602.00	8,322	1.6E-05	1.4E-02		X
79016	Trichloroethylene	1.66E+02	7.90E-02	9.10E-06	1.47E+03	4.21E-01	1.03E-02	25	360.36	544.20	7,505	1.0E-06	0.0E+00		
79209	Methyl acetate	3.26E+00	1.04E-01	1.00E-05	2.00E+03	4.84E-03	1.18E-04	25	329.80	506.70	7,260	0.0E+00	3.5E+00		X
79345	1,1,2,2-Tetrachloroethane	9.33E+01	7.10E-02	7.90E-06	2.96E+03	1.41E-02	3.44E-04	25	419.60	661.15	8,996	5.8E-05	2.1E-01		X
79469	2-Nitropropane	1.17E+01	9.23E-02	1.01E-05	1.70E+04	5.03E-03	1.23E-04	25	393.20	594.00	8,383	2.7E-03	2.0E-02		
80626	Methylmethacrylate	6.98E+00	7.70E-02	8.60E-06	1.50E+04	1.38E-02	3.36E-04	25	373.50	567.00	8,975	0.0E+00	7.0E-01		
83329	Acenaphthene	7.08E+03	4.21E-02	7.69E-06	3.57E+00	6.34E-03	1.55E-04	25	550.54	803.15	12,155	0.0E+00	2.1E-01		X
86737	Fluorene	1.38E+04	3.63E-02	7.88E-06	1.98E+00	2.60E-03	6.34E-05	25	570.44	870.00	12,666	0.0E+00	1.4E-01		X
87683	Hexachloro-1,3-butadiene	5.37E+04	5.61E-02	6.16E-06	3.20E+00	3.33E-01	8.13E-03	25	486.15	738.00	10,206	2.2E-05	7.0E-04		X

88722	o-Nitrotoluene	3.24E+02	5.87E-02	8.67E-06	6.50E+02	5.11E-04	1.25E-05	25	495.00	720.00	12,239	0.0E+00	3.5E-02		X
91203	Naphthalene	2.00E+03	5.90E-02	7.50E-06	3.10E+01	1.98E-02	4.82E-04	25	491.14	748.40	10,373	0.0E+00	3.0E-03		
91576	2-Methylnaphthalene	2.81E+03	5.22E-02	7.75E-06	2.46E+01	2.12E-02	5.17E-04	25	514.26	761.00	12,600	0.0E+00	7.0E-02		X
92524	Biphenyl	4.38E+03	4.04E-02	8.15E-06	7.45E+00	1.23E-02	2.99E-04	25	529.10	789.00	10,890	0.0E+00	1.8E-01		X
95476	o-Xylene	3.63E+02	8.70E-02	1.00E-05	1.78E+02	2.12E-01	5.18E-03	25	417.60	630.30	8,661	0.0E+00	1.0E-01		
95501	1,2-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	1.56E+02	7.77E-02	1.90E-03	25	453.57	705.00	9,700	0.0E+00	2.0E-01		
95578	2-Chlorophenol	3.88E+02	5.01E-02	9.46E-06	2.20E+04	1.60E-02	3.90E-04	25	447.53	675.00	9,572	0.0E+00	1.8E-02		X
95636	1,2,4-Trimethylbenzene	1.35E+03	6.06E-02	7.92E-06	5.70E+01	2.52E-01	6.14E-03	25	442.30	649.17	9,369	0.0E+00	6.0E-03		
96184	1,2,3-Trichloropropane	2.20E+01	7.10E-02	7.90E-06	1.75E+03	1.67E-02	4.08E-04	25	430.00	652.00	9,171	5.7E-04	4.9E-03	X	
96333	Methyl acrylate	4.53E+00	9.76E-02	1.02E-05	6.00E+04	7.68E-03	1.87E-04	25	353.70	536.00	7,749	0.0E+00	1.1E-01		X
97632	Ethylmethacrylate	2.95E+01	6.53E-02	8.37E-06	3.67E+03	3.44E-02	8.40E-04	25	390.00	571.00	10,957	0.0E+00	3.2E-01		X
98066	tert-Butylbenzene	7.71E+02	5.65E-02	8.02E-06	2.95E+01	4.87E-01	1.19E-02	25	442.10	1220.00	8,980	0.0E+00	1.4E-01		X
98828	Cumene	4.89E+02	6.50E-02	7.10E-06	6.13E+01	4.74E+01	1.46E-02	25	425.56	631.10	10,335	0.0E+00	4.0E-01		
98862	Acetophenone	5.77E+01	6.00E-02	8.73E-06	6.13E+03	4.38E-04	1.07E-05	25	475.00	709.50	11,732	0.0E+00	3.5E-01		X
98953	Nitrobenzene	6.46E+01	7.60E-02	8.60E-06	2.09E+03	9.82E-04	2.39E-05	25	483.95	719.00	10,566	0.0E+00	2.0E-03		
100414	Ethylbenzene	3.63E+02	7.50E-02	7.80E-06	1.69E+02	3.22E-01	7.86E-03	25	409.34	617.20	8,501	0.0E+00	1.0E+00		
100425	Styrene	7.76E+02	7.10E-02	8.00E-06	3.10E+02	1.12E-01	2.74E-03	25	418.31	636.00	8,737	0.0E+00	1.0E+00		
100447	Benzylchloride	6.14E+01	7.50E-02	7.80E-06	5.25E+02	1.70E-02	4.14E-04	25	452.00	685.00	8,773	4.9E-05	0.0E+00	X	
100527	Benzaldehyde	4.59E+01	7.21E-02	9.07E-06	3.30E+03	9.73E-04	2.37E-05	25	452.00	695.00	11,658	0.0E+00	3.5E-01		X
103651	n-Propylbenzene	5.62E+02	6.01E-02	7.83E-06	6.00E+01	4.37E-01	1.07E-02	25	432.20	630.00	9,123	0.0E+00	1.4E-01		X
104518	n-Butylbenzene	1.11E+03	5.70E-02	8.12E-06	2.00E+00	5.38E-01	1.31E-02	25	456.46	660.50	9,290	0.0E+00	1.4E-01		X
106423	p-Xylene	3.89E+02	7.69E-02	8.44E-06	1.85E+02	3.13E-01	7.64E-03	25	411.52	616.20	8,525	0.0E+00	1.0E-01		
106467	1,4-Dichlorobenzene	6.17E+02	6.90E-02	7.90E-06	7.90E+01	9.82E-02	2.39E-03	25	447.21	684.75	9,271	0.0E+00	8.0E-01		
106934	1,2-Dibromoethane (ethylene dibr	2.50E+01	2.17E-02	1.19E-05	4.18E+03	3.04E-02	7.41E-04	25	404.60	583.00	8,310	2.2E-04	2.0E-04		
106990	1,3-Butadiene	1.91E+01	2.49E-01	1.08E-05	7.35E+02	3.01E+00	7.34E-02	25	268.60	425.00	5,370	3.0E-02	2.0E-03		
107028	Acrolein	2.76E+00	1.05E-01	1.22E-05	2.13E+05	4.99E-03	1.22E-04	25	325.60	506.00	6,731	0.0E+00	2.0E-05		
107062	1,2-Dichloroethane	1.74E+01	1.04E-01	9.90E-06	8.52E+03	4.00E-02	9.77E-04	25	356.65	561.00	7,643	2.6E-05	0.0E+00		
107131	Acrylonitrile	5.90E+00	1.22E-01	1.34E-05	7.40E+04	4.21E-03	1.03E-04	25	350.30	519.00	7,786	6.8E-05	2.0E-03		
108054	Vinyl acetate	5.25E+00	8.50E-02	9.20E-06	2.00E+04	2.09E-02	5.10E-04	25	345.65	519.13	7,800	0.0E+00	2.0E-01		
108101	Methylisobutylketone (4-methyl-2-	9.06E+00	7.50E-02	7.80E-06	1.90E+04	5.64E-03	1.38E-04	25	389.50	571.00	8,243	0.0E+00	3.0E+00		
108383	m-Xylene	4.07E+02	7.00E-02	7.80E-06	1.61E+02	3.00E-01	7.32E-03	25	412.27	617.05	8,523	0.0E+00	1.0E-01		
108678	1,3,5-Trimethylbenzene	1.35E+03	6.02E-02	8.67E-06	2.00E+00	2.41E-01	5.87E-03	25	437.89	637.25	9,321	0.0E+00	6.0E-03		
108872	Methylcyclohexane	7.85E+01	7.35E-02	8.52E-06	1.40E+01	4.22E+00	1.03E-01	25	373.90	572.20	7,474	0.0E+00	3.0E+00		
108883	Toluene	1.82E+02	8.70E-02	8.60E-06	5.26E+02	2.72E-01	6.62E-03	25	383.78	591.79	7,930	0.0E+00	4.0E-01		
108907	Chlorobenzene	2.19E+02	7.30E-02	8.70E-06	4.72E+02	1.51E-01	3.69E-03	25	404.87	632.40	8,410	0.0E+00	6.0E-02		
109693	1-Chlorobutane	1.72E+01	8.26E-02	1.00E-05	1.10E+03	6.93E-01	1.69E-02	25	351.60	542.00	7,263	0.0E+00	1.4E+00		X
110009	Furan	1.86E+01	1.04E-01	1.22E-05	1.00E+04	2.21E-01	5.39E-03	25	304.60	490.20	6,477	0.0E+00	3.5E-03		X
110543	Hexane	4.34E+01	2.00E-01	7.77E-06	1.24E+01	6.82E+01	1.66E+00	25	341.70	508.00	6,895	0.0E+00	2.0E-01		
111444	Bis(2-chloroethyl)ether	1.55E+01	6.92E-02	7.53E-06	1.72E+04	7.36E-04	1.80E-05	25	451.15	659.79	10,803	3.3E-04	0.0E+00		
115297	Endosulfan	2.14E+03	1.15E-02	4.55E-06	5.10E-01	4.58E-04	1.12E-05	25	674.43	942.94	14,000	0.0E+00	2.1E-02		X
118741	Hexachlorobenzene	5.50E+04	5.42E-02	5.91E-06	5.00E-03	5.40E-02	1.32E-03	25	582.55	825.00	14,447	4.6E-04	2.8E-03		X
120821	1,2,4-Trichlorobenzene	1.78E+03	3.00E-02	8.23E-06	4.88E+01	5.81E-02	1.42E-03	25	486.15	725.00	10,471	0.0E+00	4.0E-03		
123739	Crotonaldehyde (2-butenal)	4.82E+00	9.56E-02	1.07E-05	3.69E+04	7.99E-04	1.95E-05	25	375.20	568.00	9	5.4E-04	0.0E+00	X	
124481	Chlorodibromomethane	6.31E+01	1.96E-02	1.05E-05	2.60E+03	3.20E-02	7.81E-04	25	416.14	678.20	5,900	2.4E-05	7.0E-02	X	X
126987	Methacrylonitrile	3.58E+01	1.12E-01	1.32E-05	2.54E+04	1.01E-02	2.46E-04	25	363.30	554.00	7,600	0.0E+00	7.0E-04		
126998	2-Chloro-1,3-butadiene (chloropre	6.73E+01	8.58E-02	1.03E-05	2.12E+03	4.91E-01	1.20E-02	25	332.40	525.00	8,075	0.0E+00	7.0E-03		
127184	Tetrachloroethylene	1.55E+02	7.20E-02	8.20E-06	2.00E+02	7.53E-01	1.84E-02	25	394.40	620.20	8,288	5.9E-06	6.0E-01		
129000	Pyrene	1.05E+05	2.72E-02	7.24E-06	1.35E+00	4.50E-04	1.10E-05	25	667.95	936	14370	0.0E+00	1.1E-01		X
132649	Dibenzofuran	5.15E+03	2.38E-02	6.00E-06	3.10E+00	5.15E-04	1.26E-05	25	560	824	66400	0.0E+00	1.4E-02		X
135988	sec-Butylbenzene	9.66E+02	5.70E-02	8.12E-06	3.94E+00	5.68E-01	1.39E-02	25	446.5	679	88730	0.0E+00	1.4E-01		X
141786	Ethylacetate	6.44E+00	7.32E-02	9.70E-06	8.03E+04	5.64E-03	1.38E-04	25	350.26	523.3	7633.66	0.0E+00	3.2E+00		X
156592	cis-1,2-Dichloroethylene	3.55E+01	7.36E-02	1.13E-05	3.50E+03	1.67E-01	4.07E-03	25	333.65	544	7192	0.0E+00	3.5E-02		X
156605	trans-1,2-Dichloroethylene	5.25E+01	7.07E-02	1.19E-05	6.30E+03	3.84E-01	9.36E-03	25	320.85	516.5	6717	0.0E+00	7.0E-02		X
205992	Benzo(b)fluoranthene	1.23E+06	2.26E-02	5.56E-06	1.50E-03	4.54E-03	1.11E-04	25	715.9	969.27	17000	2.1E-04	0.0E+00	X	
218019	Chrysene	3.98E+05	2.48E-02	6.21E-06	6.30E-03	3.87E-03	9.44E-05	25	714.15	979	16455	2.1E-06	0.0E+00	X	
309002	Aldrin	2.45E+06	1.32E-02	4.86E-06	1.70E-02	6.95E-03	1.70E-04	25	603.01	839.37	15000	4.9E-03	1.1E-04		X
319846	alpha-HCH (alpha-BHC)	1.23E+03	1.42E-02	7.34E-06	2.00E+00	4.34E-04	1.06E-05	25	596.55	839.36	15000	1.8E-03	0.0E+00		
541731	1,3-Dichlorobenzene	1.98E+03	6.92E-02	7.86E-06	1.34E+02	1.27E-01	3.09E-03	25	446	684	9230.18	0.0E+00	1.1E-01		X
542756	1,3-Dichloropropene	4.57E+01	6.26E-02	1.00E-05	2.80E+03	7.24E-01	1.77E-02	25	381.15	587.38	7900	4.0E-06	2.0E-02		
630206	1,1,1,2-Tetrachloroethane	1.16E+02	7.10E-02	7.90E-06	1.10E+03	9.90E-02	2.41E-03	25	403.5	624	9768.282525	7.4E-06	1.1E-01		X
1634044	MTBE	7.26E+00	1.02E-01	1.05E-05	5.10E+04	2.56E-02	6.23E-04	25	328.3	497.1	6677.66	0.0E+00	3.0E+00		
7439976	Mercury (elemental)	5.20E+01	3.07E-02	6.30E-06	2.00E+01	4.40E-01	1.07E-02	25	629.88	1750	14127	0.0E+00	3.0E-04		

APPENDIX C

CONTAMINANT MASS AND VOLUME CALCULATIONS

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: NAVFAC, NAS South Weymouth, Building 82 Site	FILE No:	BY: CAH	PAGE: 1 of 1
SUBJECT: Estimate mass and volume of COC plumes		CHECKED BY: JWL	DATE: 07/13/2012

Purpose: Estimate volume and mass of TCE, NNPA, and 1,1-DCA plumes.

Discussion:

The attached spreadsheet provides an estimate of the volume of contaminated groundwater and the mass of the contaminants.

<u>TCE (shallow and deep interval)</u>
The TCE plume at each elevation interval was identified as shown on Figures 2-1 and 2-2. The plume limits for the shallow and deep were established 2.5 ug/L (0.5x MCL) and at 5 ug/L (MCL), respectively. The geometric mean of points within the referenced plume limits were used as the mean concentration of the plume. Sorbed TCE mass was calculated by using partition coefficients from literature, and the value for fractional organic carbon.

<u>1,1-DCA (shallow interval)</u>
The 1,1-DCA plume was identified in the shallow interval, as shown on Figure 2-1. The PRG is 70 µg/L, and a 50 µg/L contour was estimated. The geometric mean of the maximum (99 µgL) and 50 ug/L was used as the mean concentration of the plume. The sorbed 1,1-DCA mass was calculated by using partition coefficients from literature, and the value for fractional organic carbon.

<u>NNPA (shallow interval)</u>
The NNPA plume was identified in the shallow interval, as shown on Figure 2-1. There is no MCL for NNPA. The geometric mean of the maximum at MW-200S and PRG was used as the mean concentration of the plume. Sorbed NNPA mass was calculated by using partition coefficients from literature, and the value for fractional organic carbon.

NAS South Weymouth
Building 82 FS
COC Mass Calculations
9/16/2010 (note added 7/13/12)

Zone Thickness, ft	Location	ID on figs	Area, ft2	Vol, in place, ft3	n	Max C, ug/L	Contour C, ug/L	Vol, water, gal
20	Shallow 2.5 ug/l TCE plume		4,633	92,660	0.25	8.5	2.5	173,000
20	Deep 5 ug/l TCE plume		40,211	804,220	0.2	9	5	1,203,000
10	Shallow 1,1-DCA (GP-A01)		300	3,000	0.25	99	50	6,000
10	Shallow 1,1,1-TCA (GP-A01)		300	3,000	0.25	320	200	6,000
10	Shallow NNPA Location (MW-200S)		300	3,000	0.25	0.29	0.073	6,000

Total	

n = 0.25 for S ; 0.20 for D

foc	0.002
bulk density, lb/f	110

Koc x foc = Kd
Kd = Cs/Cw
Kd * Cw = Cs

NAS South Weymouth
Building 82 FS
COC Mass Calculations
9/16/2010 (note added 7/13/12)

		Aqueous							
Zone Thickness, ft	Location	Ave TCE, ug/L (1)	TCE, lb	Ave 1,1-DCA ug/L	1,1-DCA lb	Ave 1,1,1-TCA ug/L	1,1,1-TCA lb	Ave NNPA, ug/L	NNPA, lb
20	Shallow 2.5 ug/l TCE plume	3.5	5.10E-03						
20	Deep 5 ug/l TCE plume	11	0.109						
10	Shallow 1,1-DCA (GP-A01)			70	3.52E-03				
10	Shallow 1,1,1-TCA (GP-A01)					253	1.27E-02		
10	Shallow NNPA Location (MW-200S)							0.15	7.28E-06
Total			**1.14E-01**		**3.52E-03**		**1.27E-02**		**7.28E-06**

(1) - Ave TCE for Deep plume based on geometric mean of all data.

n = 0.25 for S ; 0.20 for D

foc	0.002
bulk density, lb/	110

Koc x foc = Kd
Kd = Cs/Cw
Kd * Cw = Cs

NAS South Weymouth
Building 82 FS
COC Mass Calculations
9/16/2010 (note added 7/13/12)

		TCE, sorbed					1,1-DCA sorbed				
Zone Thickness, ft	Location	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed
20	Shallow 2.5 ug/l TCE plume	160	0.32	1	10,192,600	1.15E-02					
20	Deep 5 ug/l TCE plume	160	0.32	3	88,464,200	3.07E-01					
10	Shallow 1,1-DCA (GP-A01)						30	0.06	4.22137	330,000	1.39E-03
10	Shallow 1,1,1-TCA (GP-A01)										
10	Shallow NNPA Location (MW-200S)										
Total						**3.19E-01**					**1.39E-03**

n = 0.25 for S ; 0.20 for D

foc	0.002
bulk density, lb/f	110

Koc x foc = Kd
Kd = Cs/Cw
Kd * Cw = Cs

NAS South Weymouth
Building 82 FS
COC Mass Calculations
9/16/2010 (note added 7/13/12)

		1,1,1-TCA sorbed					**NNPA, sorbed**				
Zone Thickness, ft	Location	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed
20	Shallow 2.5 ug/l TCE plume										
20	Deep 5 ug/l TCE plume										
10	Shallow 1,1-DCA (GP-A01)										
10	Shallow 1,1,1-TCA (GP-A01)	152	0.30	76.907	330,000	0.025					
10	Shallow NNPA Location (MW-200S)						130	0.26	3.78E-02	330,000	1.25E-05
Total						**2.54E-02**					**1.25E-05**

n = 0.25 for S ; 0.20 for D

foc	0.002
bulk density, lb/	110

Koc x foc = Kd
Kd = Cs/Cw
Kd * Cw = Cs

APPENDIX D

PROCESS CALCULATIONS AND VENDOR INFORMATION

Alternative G-2

Tetra Tech			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: CAH	PAGE: 1 of 3
SUBJECT: NA South Weymouth – Building 82 FS – Estimate of Chemical oxidizer dose – Alternative G-2		CHECKED BY: JWL	DATE: 02/28/2012

Purpose: Estimate quantity of chemical oxidizer for Alternative G-2. Also, estimate unit quantities for cost estimate.

There are four plumes:

Plume	Maximum detected concentration, ug/L
TCE, shallow	5
TCE, deep	25
1,1-DCA (shallow)	99
NNPA (shallow)	0.29

Because the maximum concentrations are so low, a stoichiometric dose does not need to be calculated. The natural oxidant demand will determine the dose. However, the natural oxidant demand is not known, so typical dosage rates based on other quotes will be used.

The oxidizer will likely be determined based in a treatability pilot study. TCE, 1,1-DCA, and NNPA could be treated with Fenton's reagent or other oxidizers. The low concentrations are feasible for permanganates (although permanganates are less effective on DCA). However, because of the significant amount of manganese in the groundwater, permanganate is not proposed to limit the overall manganese loading.

Based on other Fenton's reagent proposals (from Geocleanse), the typical dosage range is 0.2 to 0.5 gallons of 12.5% H2O2 per cubic feet of saturated soil. Because the site is expected to have a high natural demand, based on the high concentrations of manganese and iron, and the generally reduced groundwater conditions, the upper end will be assumed.

Therefore use 0.5 gal 12.5% solution/ft3 saturated soil.

From other calculation, the following table summarizes the dosages:

Plume	Depth	Area, ft2	Thickness, ft	Vol sat soil, ft3	Vol 12.5 % H2O2, gallons
TCE	Shallow	1,963	20	39,300	19,600
TCE	Deep	18,778	20	375,500	187,800
1,1-DCA	Shallow	300	10	3,000	1,500
NNPA	Shallow	300	10	3,000	1,500
Total					210,400

The injection spacing at the Building 81 pilot study was 20 feet. Because Building 82 subsurface is similar to Building 81 subsurface, use the same spacings. Assume that 10' long depth intervals can be injected at each injection point, so for 15 to 20 thick zones, two injection points will be needed. The injection area for the shallow TCE zone is defined by an assumed treatment diameter of 50 feet. The injection area in the deep TCE zone is defined by the 10 µg/l isocontour.

The area for each point:

Area = $20^2\pi/4 = 314\ ft^2$

For 1,1-DCA and NNPA plumes, assume 7 injection locations, one at the center and the rest at hexagonal points 15' from the center. One injection depth per location.

For TCE Shallow plume:

1,963 ft^2/314 ft^2 = 6.25, round to 7 locations, 2 depths per location.

For TCE Deep plume:

18,778 ft^2/314 ft^2 = 59.8, round to 60 locations, 2 depths per location
Note: a portion of the calculated locations may not be implemented due to access limitations and planned future use within the Building 41 foot print

Assume that shallow points can be installed with DPT, but deep points will use conventional HSA drilling.

Plume	No. Shallow (DPT)	No. Deep (Wells)	Notes
TCE	7 x 2	60 x 2	Half 30'; half 40'
1,1-DCA	7 x 1		
NNPA	7 x 1		
TOTAL	28	120	

Assume temporary injection points for shallow and permanent wells for deep.

For DPT, assume 8 DPT injections per day:

28/8 = 3.5 round up to 4 days.

For the wells, assume no logging and the wells are installed separately for later injection. Assume 8 per day.

120/8 = 15 days

Total feet: 60 x 30' + 60 x 40' = 4,200 feet

For injection, equipment and labor, assume $4,000 $/day.

Injection:

DPT phase – 6 days

Deep wells (assume 20 wells per day can be injected.): 120/20 = 6 days.

Mob and demob: separate mobs for DPT rig, HSA rig, and injection equipment. For injection equipment, use $15,000 for mob, for typical projects.

For reagent cost, assume 1.5 $/gal for 50% solution.

Estimate water to dilute 50% H_2O_2 to 12.5 % H_2O_2

Specific gravity 50% - 1.19 (per FMC msds 40 to 60%)
Specific gravity 12.5% - 1.05 (per JT Baker msds 10%)

Basis: 1 gallon of 12.5% H_2O_2

1 gal x (8.34 x 1.05) lb/gal x 0.125 = 1.095 lb H_2O_2
1 gal x (8.34 x 1.05) lb/gal x 0.875 = 7.66 lb H_2O = 0.92 gallons H_2O

Calculate volume of 50% solution with the above H_2O_2 mass:

1.095 lb H_2O_2 x 1 lb 50% solution/0.5 lb H_2O_2 x 1 gal 50% solution/(8.34 x 1.05) lb = 0.25 gal 50%

The 50% solution will have the same mass of H_2O as H_2O_2:

1.095 lb H_2O x gal/8.34 lb = 0.13 gallons of H_2O.

For 1 gallon of 12.5% solution, the additional volume of water to get from 50% to 12.5 is:

0.92 gall – 0.13 gal = 0.79 gal

Thus, the dilution water needed can be calculated by multiplying the total gallons of 12.5% solution by 0.79.

SOUTH WEYMOUTH
BUILDING 82 FS
CHEM OX SUMMARY - G-2
2/28/2012

Plume	Locations	Points per location	No. of injection points	12.5% peroxide (gal)	Dilution Water (gal)
TCE shallow	7	2	14	19,600	15,000
TCE deep	60	2	120	187,800	148,000
1,1-DCA shallow	7	1	7	1,500	1,000
NNPA shallow	7	1	7	1,500	1,000
			TOTAL	210,400	166,000

Subtotal shallow	21		28	22,600	17,000
Subtotal deep	60		120	187,800	148,000

Each layer is about 15 to 20 feet thick, so there are 2 10' screens per location (except at 1,1-DCA and NNPA)
Gallons of water is water to dilute 50% solution to 12.5%.

Alternative G-2A

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: CAH	PAGE: 1 of 4
SUBJECT: NA South Weymouth – Building 82 FS – Estimate of Chemical oxidizer dose – Alternative G-2A		CHECKED BY: JWL	DATE: 07/16/2012

Purpose: Estimate quantity of chemical oxidizer for Alternative G-2A. Also, estimate unit quantities for cost estimate.

There are four plumes:

Plume	Maximum detected concentration, ug/L
TCE, shallow	5
TCE, deep	25
1,1-DCA (shallow)	99
NNPA (shallow)	0.29

Because the maximum concentrations are so low, a stoichiometric dose does not need to be calculated. The natural oxidant demand will determine the dose. However, the natural oxidant demand is not known, so typical dosage rates based on other quotes will be used.

The oxidizer will likely be determined based in a treatability pilot study. TCE, 1,1-DCA, and NNPA could be treated with Fenton's reagent or other oxidizers. The low concentrations are feasible for permanganates (although permanganates are less effective on DCA). However, because of the significant amount of manganese in the groundwater, permanganate is not proposed to limit the overall manganese loading.

Based on other Fenton's reagent proposals (from Geocleanse), the typical dosage range is 0.2 to 0.5 gallons of 12.5% H2O2 per cubic feet of saturated soil. Because the site is expected to have a high natural demand, based on the high concentrations of manganese and iron, and the generally reduced groundwater conditions, the upper end will be assumed.

Therefore use 0.5 gal 12.5% solution/ft3 saturated soil.

From other calculation, the following table summarizes the dosages:

Plume	Depth	Area, ft2	Thickness, ft	Vol sat soil, ft3	Vol 12.5 % H2O2, gallons
TCE	Shallow	1,963	20	39,300	19,600
TCE	Deep	18,778	20	375,500	187,800
1,1-DCA	Shallow	300	10	3,000	1,500
NNPA	Shallow	300	10	3,000	1,500
TCE	Deep (between 5 and 10 ug/L contours)	17,300	20	346,000	173,000
Total					383,000

The injection spacing at the Building 81 pilot study was 20 feet. Because Building 82 subsurface is similar to Building 81 subsurface, use the same spacings. Assume that 10' long depth intervals can be injected at each injection point, so for 15 to 20 thick zones, two injection points will be needed. The injection area for the shallow TCE zone is defined by an assumed treatment diameter of 50 feet. The injection area in the deep TCE zone is defined by the 5 µg/l isocontour.

The area for each point:

Area = $20^2\pi/4 = 314\ ft^2$

For 1,1-DCA and NNPA plumes, assume 7 injection locations, one at the center and the rest at hexagonal points 15' from the center. One injection depth per location.

For TCE Shallow plume:

1,963 ft^2/314 ft^2 = 6.25, round to 7 locations, 2 depths per location.

For TCE Deep plume:

From Alternative G-2, 18,778 ft^2/314 ft^2 = 59.8, round to 60 locations, 2 depths per location
Note: a portion of the calculated locations may not be implemented due to access limitations and planned future use within the Building 41 foot print

A figure of Alternative G-2 boring locations was used to determine the number of additional deep borings compared to Alternative G-2. An addition 44 points are needed.

Assume that shallow points can be installed with DPT, but deep points will use conventional HSA drilling.

Plume	No. Shallow (DPT)	No. Deep (Wells)	Notes
TCE	7 x 2	60 x 2 + 44 x 2	Half 30'; half 40'
1,1-DCA	7 x 1		
NNPA	7 x 1		
TOTAL	28	120 + 88 = 208	

Assume temporary injection points for shallow and permanent wells for deep.

For DPT, assume 8 DPT injections per day:

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28/8 = 3.5 round up to 4 days.

For the wells, assume no logging and the wells are installed separately for later injection. Assume 8 per day.

208/8 = 26 days

Total feet: (60+44) x 30’ + (60+44) x 40’ = 7,280 feet

For injection, equipment and labor, assume $4,000 $/day.

Injection:

DPT phase – 6 days

Deep wells (assume 20 wells per day can be injected.): 208/20 = 10 days.

Mob and demob: separate mobs for DPT rig, HSA rig, and injection equipment. For injection equipment, use $15,000 for mob, for typical projects.

For reagent cost, assume 1.5 $/gal for 50%

Estimate water to dilute 50% H_2O_2 to 12.5 % H_2O_2

Specific gravity 50% - 1.19 (per FMC msds 40 to 60%)
Specific gravity 12.5% - 1.05 (per JT Baker msds 10%)

Basis: 1 gallon of 12.5% H_2O_2

1 gal x (8.34 x 1.05) lb/gal x 0.125 = 1.095 lb H_2O_2
1 gal x (8.34 x 1.05) lb/gal x 0.875 = 7.66 lb H_2O = 0.92 gallons H_2O

Calculate volume of 50% solution with the above H_2O_2 mass:

1.095 lb H_2O_2 x 1 lb 50% solution/0.5 lb H_2O_2 x 1 gal 50% solution/(8.34 x 1.05) lb = 0.25 gal 50%

The 50% solution will have the same mass of H_2O as H_2O_2:

1.095 lb H_2O x gal/8.34 lb = 0.13 gallons of H_2O.

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For 1 gallon of 12.5% solution, the additional volume of water to get from 50% to 12.5 is:

0.92 gall – 0.13 gal = 0.79 gal

Thus, the dilution water needed can be calculated by multiplying the total gallons of 12.5% solution by 0.79.

383,000 x 0.79 = 303,000 gallons of water

SOUTH WEYMOUTH
BUILDING 82 FS
CHEM OX SUMMARY - G-2A
7/16/2012

Plume	Locations	Points per location	No. of injection points	12.5% peroxide (gal)	Dilution Water (gal)
TCE shallow	7	2	14	19,600	15,000
TCE deep	60	2	120	187,800	148,000
TCE deep (5-10 ug/L)	44	2	88	173,000	137,000
1,1-DCA shallow	7	1	7	1,500	1,000
NNPA shallow	7	1	7	1,500	1,000
			TOTAL	383,400	303,000

Subtotal shallow	21		28	22,600	17,000
Subtotal deep	104		208	360,800	285,000

Each layer is about 15 to 20 feet thick, so there are 2 10' screens per location (except at 1,1-DCA and NNPA)
Gallons of water is water to dilute 50% solution to 12.5%.

Alternative G-3

Purpose: Determine placement of injection points for enhanced bioremediation amendment injections. Quantities estimated based on calculations provided by bioremediation vendor (EOS).

There are four plumes:

Plume	Maximum detected concentration, ug/L
TCE, shallow	5
TCE, deep	25
1,1-DCA (shallow)	99
NNPA (shallow)	0.29

Because the maximum concentrations are so low, a stoichiometric dose does not need to be calculated for enchanced bioremediation. The natural oxygen demand within the NNPA plume will determine the dose for ORC. Hydrogen demand and the capacity of the aquifer to absorb oil were used to determine EOS dosages for 1,1-DCA and TCE. Site specific values for these design criteria are not known, so typical values based on vendor quotes will be used.

The amendment(s) will likely be determined based on a treatability pilot study. Emulsified oil substrate (EOS) will be used to facilitate an anaerobic environment within the shallow and deep TCE plume. EOS AquaBupH may be needed to buffer the treatment area to prevent decreases in pH during anaerobic processes, which could affect biological populations and remedial performance. Standard EOS formulation was used for cost estimation purposes. Oil absorptive capacity and groundwater and soil acidity tests are recommended to determine site specific requirements and dosages and pre-pilot study amendment selection.

ORC will be used to enhance aerobic biological conditions in the NNPA plume treatment.

The localized plume treatment will be conducted for the shallow NNPA, 1,1-DCA plumes and barrier treatment of the shallow and deep TCE plumes will be conducted.

From vendor calculations, the following table summarizes the EOS and ORC dosages:

EOS

Plume	Area, ft2	Thickness, ft	Vol sat soil, ft3	EOS substrate per event, gallons	Dilution water per event, gallons	Total injection volume per event, gallons
Shallow TCE	1,963	20	39,300	330	2,970	3,300
Deep TCE	18,778	20	375,500	4,510	40,590	45,100
Shallow 1,1-DCA	300	10	3,000	110	990	1,100

ORC

Plume	Area, ft2	Thickness, ft	Vol sat soil, ft3	ORC substrate, pounds	Dilution Water, gallons
Shallow NNPA	300	10	3,000	150	60

The injection spacing at Building 81 pilot study testing was 20 feet. Because Building 82 subsurface is similar to Building 81 subsurface, use the same spacings. Assume that 10' long depth intervals can be injected at each deep injection point, so for 15 to 20 thick zones, two injection points will be needed. The injection area for the shallow TCE zone is defined by an assumed barrier treatment length of 60 feet. The injection area in the deep TCE zone is defined by the 10 µg/l isocontour.

NNPA:
Assume 3 injection locations, oriented in a triangle and centered with 15' spacing from GP-A01. One injection depth per location.

1,1-DCA:
Assume 7 injection locations, one at the center and the rest at hexagonal points 15' from the center. One injection depth per location.

TCE Shallow plume:
Assume one barrier is needed with 10-foot injection spacing along a 60-foot line perpendicular to the orientation of the shallow TCE plume and downgradient of GP-KO9 (7 points, 1 injection depth per location). With a calculated shallow TCE plume velocity value of 199 ft/yr, the barrier is expected to effectively treat 995 feet of TCE transport within 5 years, the typical lifespan of EOS. Therefore, only 1 injection event is required in the shallow TCE plume.

TCE Deep plume:
Assume barrier spacing of 50-feet and injection point spacing of 10-feet (based on the calculated TCE transport velocity of 2.6 ft/yr and a treatment period of 20 years). Assume reinjection every 5 years.
Barrier A – 40-feet long, 5 points, 2 depths per location
Barrier B – 50-feet long, 6 points, 2 depths per location
Barrier C – 60-feet long, 7 points, 2 depths per location
Barrier D – 80-feet long, 9 points, 2 depths per location
Barrier E – 80-feet long, 9 points, 2 depths per location
Barrier F – 40-feet long, 5 points, 2 depths per location
Barrier G – 20-feet long, 3 points, 2 depths per location

Assume that shallow points can be installed with DPT, but deep points will use conventional HSA drilling.

Plume	No. Shallow (DPT)	No. Deep (Wells)	Notes
TCE	7 x 1	44 x 2	Half 30'; half 40'
1,1-DCA	7 x 1		
NNPA	7 x 1		
TOTAL	21	88	

Assume temporary injection points for shallow and permanent wells for deep.

For DPT, assume 8 DPT injections per day:

21 points/8 points per day = 2.6 days, round up to 3 days. Assume 1 injection event will treat the shallow 1,1-DCA, NNPA, and TCE plumes.

For the wells, assume no logging and the wells are installed separately for later injection. Assume 8 per day.

88 wells /8 wells per day= 11 days

Total feet: 44 x 30' + 44 x 40' = 3,080 feet

For injection, equipment and labor, assume $4,000/day.

Injection:

DPT phase – 3 days per event

Deep wells (assume 20 wells per day can be injected.): 88/20 = 4.4 days, round up to 5 days. Assume 4 injection events for treatment period of 20 years with injection events at T=0, 5, 10, and 15 years. Substrate has assumed effective lifespan of 5 years.

Mob and demob: separate mobs for DPT rig, HSA rig, and injection equipment. For injection equipment, use $10,000 for mob, for typical projects.

For EOS cost, use $1,400 per drum of EOS

Assume 10% EOS solution by volume, thus, the total injection volume can be calculated by multiplying the total gallons of EOS by 10. The dilution water volume is equal to the total injection volume minus the EOS volume.

For ORC cost, use $8.95 per lb of ORC.

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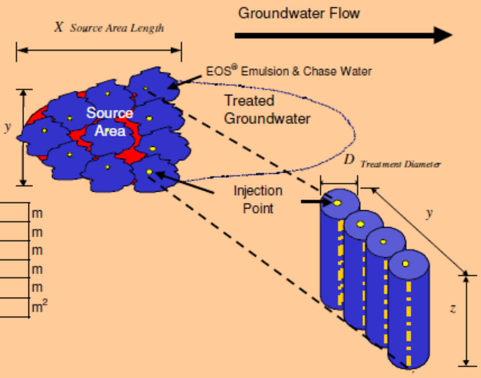
EOS Remediation, LLC

EOS® SOURCE AREA & DNAPL DESIGN WORKSHEET

U.S. Version 2.1e, Rev. Date: June 11, 2008
www.EOSRemediation.com

Help

Shallow TCE Plume -EOS



Step 1: Select a Substrate from the EOS® Family of Bioremediation Products

Substrate Selected (pick from drop down list) | EOS® 598B42 (Preferred for Chlorinateds)
For Product Literature Click Here

Step 2: EOS® Consumption During Contaminant Biodegradation / Biotransformation

Section A: Source Area Dimensions

Length of treatment area parallel to groundwater flow, "x"	68	ft	20.7	m
Width of treatment area perpendicular to groundwater flow, "y"	68	ft	20.7	m
Minimum depth to contamination	5	ft	1.5	m
Maximum depth of contamination	25	ft	7.6	m
Treatment thickness, "z"	20	ft	6.1	m
Treatment zone cross-sectional area, A = y * z	1,360	ft^2	126.3	m^2

Section B: Groundwater Flow Rate / Site Data

Soil Characteristics

Nominal Soil Type (pick from drop down list)	Sand			
Total Porosity (accept default or enter n)	0.38	(decimal)		
Effective Porosity (accept default or enter n_e)	0.25	(decimal)		
Soil bulk density; (1-n)*2.65 g/cc (accept calculated or enter dry bulk density)	1.64	g/cc	103	lbs / ft^3
Fraction of organic carbon: foc	0.0050	range: 0.0001 to 0.01		

Hydraulic Characteristics

Hydraulic Conductivity (accept default or enter K)	1.59	ft/day	5.6E-04	cm/sec
Hydraulic Gradient (accept default or enter i)	0.005	ft/ft		

Note: Since the hydraulic gradient ($i = dh/dx$) is negative, we ask you to enter $-i$ in the EOS® Design Tool so that you can enter a positive number for convenience.

Non-reactive Transport Velocity, $V_x = -(K \times i) / n_e$	0.03	ft/day	0.010	m/day
Groundwater flow rate through treatment zone, $Q = -KiA$	80.87	gallons/day	306.16	L/day

Section C: Calculated Contact Length

Contact time (τ) between oil and contaminants (accept default or enter τ)	60	typical values 60 to 180 days, see comment		
Calculated Contact Length (x) $= \tau * V_x$ — **Suggested Minimum**	5.0	ft	1.5	m
Treatment zone volume	92,480	ft^3	2,619	m^3
Treatment zone groundwater volume (volume * porosity)	262,865	gallons	995,122	L

Section D: Design Lifespan For One Application

Section D: Design Lifespan For One Application	5	year(s)	typical values 5 to 10 years	
Estimated total groundwater volume treated over design life	410,460	gallons	1,553,867	L

Section E: Electron Acceptors

Dissolved Phase Electron Donor Demand

Inputs	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry *Contaminant/ H_2 (wt/wt H_2)*	Hydrogen Demand *(g H_2)*
Dissolved Oxygen (DO)	0 to 8	5	32.0	4	7.94	978.8758862
Nitrate Nitrogen (NO_3^- - N)	1 to 10	10	62.0	5	12.30	1262.918483
Sulfate (SO_4^{2-})	10 to 500	50	96.1	8	11.91	6521.681513
Tetrachloroethene (PCE), C_2Cl_4			165.8	8	20.57	
Trichloroethene (TCE), C_2HCl_3		0.0035	131.4	6	21.73	0.250317922
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$			96.9	4	24.05	
Vinyl Chloride (VC), C_2H_3Cl			62.5	2	31.00	
Carbon tetrachloride, CCl_4			153.8	8	19.08	
Chloroform, $CHCl_3$			119.4	6	19.74	
sym-tetrachloroethane, $C_2H_2Cl_4$			167.8	8	20.82	
1,1,1-Trichloroethane (TCA), CH_3CCl_3			133.4	6	22.06	
1,1-Dichloroethane (DCA), CH_2CHCl_2			99.0	4	24.55	
Chloroethane, C_2H_5Cl			64.9	2	32.18	
Perchlorate, ClO_4^-			99.4	8	12.33	
Hexavalent Chromium, Cr[VI]			52.0	3	17.20	
User added						
User added						
User added						

Sorbed Phase Electron Donor Demand

The concentration of the sorbed contaminant can be estimated by: $C_{SOIL} = K_{OC} \times f_{oc} \times C_{WATER}$

Where: K_{oc} is partition coefficient with respect to organic carbon.
f_{oc} (fraction organic carbon) is the mass of organic matter in soil divided by the total mass of soil
C_{WATER} is the concentration of the contaminant in the groundwater

Default values for Koc taken from: US EPA, Superfund Section, APPENDIX K, Soil Organic Carbon (Koc) / Water (Kow) Partition Coefficients (Average Value Used)

Inputs Adjust K_{oc} as necessary to provide site specific estimates or enter sediment concentration (C_{SOIL})	K_{oc} (L/kg)	C_{SOIL} (mg/Kg)	Mass (g)	Hydrogen Demand ($g\,H_2$)
Tetrachloroethene (PCE), C_2Cl_4	272			
Trichloroethene (TCE), C_2HCl_3	97	52.00	223735.10	10297.79
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$	38			
Vinyl Chloride (VC), C_2H_3Cl	241			
Carbon tetrachloride, CCl_4	158			
Chloroform, $CHCl_3$	53			
sym-tetrachloroethane, $C_2H_2Cl_4$	79			
1,1,1-Trichloroethane (TCA), CH_3CCl_3	139			
1,1-Dichloroethane (DCA), CH_3CHCl_2	54			
User added				
User added				
User added				

Section F: Additional Hydrogen Demand and Carbon Losses

Generation (Potential Amount Formed)	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry *Contaminant / H_2*	Hydrogen Demand *($g\,H_2$)*	DOC Released *(moles)*
Estimated Amount of Fe^{2+} Formed	10 to 100	50	55.8	1	55.41	1402.222836	
Estimated Amount of Manganese (Mn^{2+}) Formed		5	54.9	2	27.25	285.0745723	
Estimated Amount of CH_4 Formed	5 to 20	10	16.0	8	1.99	7809.919516	
Target Amount of DOC to Release	60 to 100	75	12.0				9702.78

Design Safety Factor: 2.0 typical values 1 to 3

Calculations assume:
1.) all reactions go to completion during passage through emulsified edible oil treated zone; and,
2.) perfect reaction stoichiometry.

EOS® Requirement Calculations Based on Hydrogen Demand and Carbon Losses

Stoichiometric Hydrogen Demand	125.8	pounds
DOC Released	1,107.9	pounds

EOS® Requirement Based on Hydrogen Demand and Carbon Loss
1,681 lbs

Step 3: EOS® Requirement Based on Attachment by Aquifer Material

Soil Characteristics
Effective treatment thickness, "z_e" (typically less than 40%) 0.25
For Additional Information on Effective Thickness, Click Here

Weight of sediment to be treated 2,371,398 lbs

Adsorptive Capacity of Soil (accept default or enter site specific value) 0.0010 lbs EOS® / lbs sediment

EOS® Attachment by Aquifer Material[1]
- Fine sand with some clay 0.001 to 0.002 lbs EOS® / lbs soil
- Sand with higher silt/clay content 0.002 to 0.004 lbs EOS® / lbs soil

[1]Default values provided based on laboratory studies completed by NCSU
For Additional Data, Click Here

EOS® Requirement Based on Oil Entrapment by Aquifer Material
2,371 lbs

Summary – How much EOS® do you need?

Suggested Quantity of EOS® for Your Project 6 drums

†Exclusive license agreement with Solutions-IES under U.S. Patent # 6,398,960, E.U. Patent # EP 1 315 675 and several other pending international patents.
††EOS® is a registered trademark of EOS Remediation, LLC

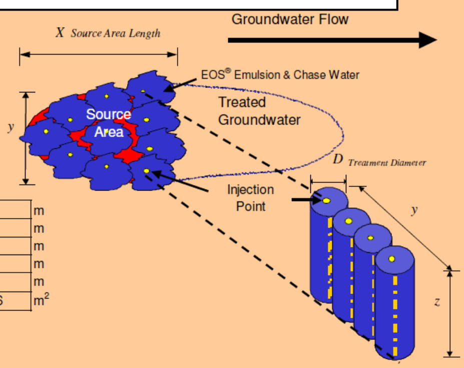
EOS Remediation, LLC

EOS® SOURCE AREA & DNAPL DESIGN WORKSHEET

U.S. Version 2.1e, Rev. Date: June 11, 2008
www.EOSRemediation.com

Help

Deep TCE Plume -EOS



Step 1: Select a Substrate from the EOS® Family of Bioremediation Products

Substrate Selected (pick from drop down list) — EOS® 598B42 (Preferred for Chlorinateds)
For Product Literature Click Here

Step 2: EOS® Consumption During Contaminant Biodegradation / Biotransformation

Section A: Source Area Dimensions

Length of treatment area parallel to groundwater flow, "x"	137	ft	41.8	m
Width of treatment area perpendicular to groundwater flow, "y"	137	ft	41.8	m
Minimum depth to contamination	25	ft	7.6	m
Maximum depth of contamination	45	ft	13.7	m
Treatment thickness, "z"	20	ft	6.1	m
Treatment zone cross-sectional area, A = y * z	2,740	ft^2	254.6	m^2

Section B: Groundwater Flow Rate / Site Data

Soil Characteristics

Nominal Soil Type (pick from drop down list)	Clay			
Total Porosity (accept default or enter n)	0.45	(decimal)		
Effective Porosity (accept default or enter n_e)	0.05	(decimal)		
Soil bulk density; (1-n)*2.65 g/cc (accept calculated or enter dry bulk density)	1.46	g/cc	91	lbs / ft^3
Fraction of organic carbon: foc	0.0050	range: 0.0001 to 0.01		

Hydraulic Characteristics

Hydraulic Conductivity (accept default or enter K)	0.01	ft/day	3.5E-06	cm/sec
Hydraulic Gradient (accept default or enter i)	0.001	ft/ft		

Note: Since the hydraulic gradient ($i = dh/dx$) is negative, we ask you to enter $-i$ in the EOS® Design Tool so that you can enter a positive number for convenience.

Non-reactive Transport Velocity, $V_x = -(K \times i) / n_e$	LESS THAN	0.01	ft/day	LESS THAN 0.003	m/day
Groundwater flow rate through treatment zone, $Q = -KiA$		0.20	gallons/day	LESS THAN 38.79	L/day

Section C: Calculated Contact Length

Contact time (τ) between oil and contaminants (accept default or enter τ)	60	typical values 60 to 180 days, see comment		
Calculated Contact Length (x) $= \tau * V_x$ — Suggested Minimum	5.0	ft	1.5	m
Treatment zone volume	375,380	ft^3	10,630	m^3
Treatment zone groundwater volume (volume * porosity)	1,263,529	gallons	4,783,310	L

Section D: Design Lifespan For One Application

	5	year(s)	typical values 5 to 10 years	
Estimated total groundwater volume treated over design life	1,263,903	gallons	4,854,109	L

Section E: Electron Acceptors

Dissolved Phase Electron Donor Demand

Inputs	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry Contaminant/ H_2 (wt/wt H_2)	Hydrogen Demand ($g H_2$)
Dissolved Oxygen (DO)	0 to 8	5	32.0	4	7.94	3057.90011
Nitrate Nitrogen (NO_3^- - N)	1 to 10	10	62.0	5	12.30	3945.217799
Sulfate (SO_4^{2-})	10 to 500	50	96.1	8	11.91	20373.01245
Tetrachloroethene (PCE), C_2Cl_4			165.8	8	20.57	
Trichloroethene (TCE), C_2HCl_3		0.00173	131.4	6	21.73	0.38651439
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$			96.9	4	24.05	
Vinyl Chloride (VC), C_2H_3Cl			62.5	2	31.00	
Carbon tetrachloride, CCl_4			153.8	8	19.08	
Chloroform, $CHCl_3$			119.4	6	19.74	
sym-tetrachloroethane, $C_2H_2Cl_4$			167.8	8	20.82	
1,1,1-Trichloroethane (TCA), CH_3CCl_3			133.4	6	22.06	
1,1-Dichloroethane (DCA), CH_3CHCl_2			99.0	4	24.55	
Chloroethane, C_2H_5Cl			64.9	2	32.18	
Perchlorate, ClO_4^-			99.4	8	12.33	
Hexavalent Chromium, Cr[VI]			52.0	3	17.20	
User added						
User added						
User added						

Tetra Tech			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: CAH	PAGE: 7 of 8
SUBJECT: NA South Weymouth – Building 82 FS – Alternative G-3 Calculations		CHECKED BY: JWL	DATE: 02/28/2012

Sorbed Phase Electron Donor Demand

The concentration of the sorbed contaminant can be estimated by: $C_{SOIL} = K_{OC} \times f_{oc} \times C_{WATER}$

Where: K_{oc} is partition coefficient with respect to organic carbon.
f_{oc} (fraction organic carbon) is the mass of organic matter in soil divided by the total mass of soil
C_{WATER} is the concentration of the contaminant in the groundwater

Default values for Koc taken from: US EPA, Superfund Section, APPENDIX K, Soil Organic Carbon (Koc) / Water (Kow) Partition Coefficients (Average Value Used)

Inputs Adjust Koc as necessary to provide site specific estimates or enter sediment concentration (C_{SOIL})	K_{oc} (L/kg)	C_{SOIL} (mg/Kg)	Mass (g)	Hydrogen Demand ($g\ H_2$)
Tetrachloroethene (PCE), C_2Cl_4	272			
Trichloroethene (TCE), C_2HCl_3	97	0.00	13.00	0.60
cis-1,2-dichloroethene (c-DCE), $C_2H_2Cl_2$	38			
Vinyl Chloride (VC), C_2H_3Cl	241			
Carbon tetrachloride, CCl_4	158			
Chloroform, $CHCl_3$	53			
sym-tetrachloroethane, $C_2H_2Cl_4$	79			
1,1,1-Trichloroethane (TCA), CH_3CCl_3	139			
1,1-Dichloroethane (DCA), CH_2CHCl_2	54			
User added				
User added				
User added				

Section F: Additional Hydrogen Demand and Carbon Losses

Generation (Potential Amount Formed)	Typical Value	GW Conc. (mg/L)	MW (g/mole)	e^- equiv./ mole	Stoichiometry *Contaminant / H_2*	Hydrogen Demand ($g\ H_2$)	DOC Released (*moles*)
Estimated Amount of $Fe2^+$ Formed	10 to 100	50	55.8	1	55.41	4380.389204	
Estimated Amount of Manganese (Mn^{2+}) Formed		5	54.9	2	27.25	890.5414653	
Estimated Amount of CH_4 Formed	5 to 20	10	16.0	8	1.99	24397.32563	
Target Amount of DOC to Release	60 to 100	100	12.0				40413.86

Design Safety Factor: 2.0 typical values 1 to 3

Calculations assume:
1.) all reactions go to completion during passage through emulsified edible oil treated zone; and,
2.) perfect reaction stoichiometry.

EOS® Requirement Calculations Based on Hydrogen Demand and Carbon Losses

Stoichiometric Hydrogen Demand	251.3	pounds
DOC Released	4,614.6	pounds

EOS® Requirement Based on Hydrogen Demand and Carbon Loss
5,760 lbs

Step 3: EOS® Requirement Based on Attachment by Aquifer Material

Soil Characteristics

Effective treatment thickness, "z_e" (typically less than 40%)	0.25	
For Additional Information on Effective Thickness, Click Here		
Weight of sediment to be treated	8,538,839	lbs
Adsorptive Capacity of Soil (accept default or enter site specific value)	0.0040	lbs EOS® / lbs sediment

EOS® Attachment by Aquifer Material[1]
- Fine sand with some clay 0.001 to 0.002 lbs EOS® / lbs soil
- Sand with higher silt/clay content 0.002 to 0.004 lbs EOS® / lbs soil

[1]Default values provided based on laboratory studies completed by NCSU
For Additional Data, Click Here

EOS® Requirement Based on Oil Entrapment by Aquifer Material
34,155 lbs

Summary – How much EOS® do you need?

Suggested Quantity of EOS® for Your Project 82 drums

†Exclusive license agreement with Solutions-IES under U.S. Patent # 6,398,960, E.U. Patent # EP 1 315 675 and several other pending international patents.
††EOS® is a registered trademark of EOS Remediation, LLC

Tetra Tech			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: CAH	PAGE: 8 of 8
SUBJECT: NA South Weymouth – Building 82 FS – Alternative G-3 Calculations		CHECKED BY: JWL	DATE: 02/28/2012

ORC *Advanced* Design Software for Grid Applications Using Slurry Injection Aug 2006
Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com
Site Name: NAS South Weymouth
Location: NNPA Plume
Consultant: Tetra Tech (Chris Hook)
NNPA

Estimated Plume Requiring Treatment

Width of plume (intersecting gw flow direction)	20	ft		
Length of plume (parallel to gw flow direction)	15	ft	300	ft^2
Depth to contaminated zone	10	ft		
Thickness of contaminated saturated zone	10	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity:	0.15	
Hydraulic conductivity	32.7	ft/day	1.2E-02	cm/sec
Hydraulic gradient	0.001	ft/ft		
Seepage velocity	79.6	ft/yr	0.218	ft/day
Treatment Zone Pore Volume	990	ft^3	7,406	gallons

Dissolved Phase Oxygen Demand:

Individual species that represent oxygen demand:	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC-Adv Dose (lb)
Benzene	0.00	0.0	3.1	0
Toluene	0.00	0.0	3.1	0
Ethylbenzene	0.00	0.0	3.2	0
Xylenes	0.00	0.0	3.2	0
MTBE	0.00	0.0	2.7	0
cis-1,2-DCE	0.00	0.0	0.7	0
Vinyl Chloride	0.00	0.0	1.3	0
TMBs	0.00	0.0	0.0	0
NNPA	0.0003	0.00002	3.0	0
Reduced metals: Fe^{+2} and Mn^{+2}	10.00	0.6	0.1	0
TPH-g	<- pull-down menu			
Measures of total oxygen demand				
Total Petroleum Hydrocarbons (see pull-down for Koc)	0.00	0.0	3.1	0
Biological Oxygen Demand (BOD)	0.00	0.0	1.0	0
Chemical Oxygen Demand (COD)	0.00	0.0	1.0	0

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.003	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw) (Adjust Koc as necessary to provide realistic estimates)	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC-Adv Dose (lb)
Benzene	123	0.00	0.0	3.1	0
Toluene	267	0.00	0.0	3.1	0
Ethylbenzene	327	0.00	0.0	3.2	0
Xylenes	298	0.00	0.0	3.2	0
MTBE	12	0.00	0.0	2.7	0
cis-1,2-DCE	80	0.00	0.0	0.7	0
Vinyl Chloride	2.5	0.00	0.0	1.3	0
TMBs	880.0	0.00	0.0	0.0	0
NNPA	300.0	0.0003	0.0	3.0	0
Measures of total oxygen demand					
Total Petroleum Hydrocarbons	373	0.00	0.0	3.1	0

Summary of Estimated ORC-Adv Requirements	Dissolved Phase ORC-Adv Demand (lbs)	Sorbed Phase ORC-Adv Demand (lbs)	Additional Demand Factor (1 to 10x)	Total ORC-Adv Demand (lbs)	ORC-Adv Cost
Total BTEX, MTBE, etc.	0	0	10.0	4	$224 <-
Total Petroleum Hydrocarbons	0	0	2.0	0	$0
Biological Oxygen Demand (BOD)	0	0	2.0	0	$0
Chemical Oxygen Demand (COD)	0	0	1.5	0	$0

Required ORC-Adv quantity (in 25 lb increments) ------------------------------> 25 **pounds ORC-Adv**

Delivery Design for ORC-Adv Slurry

Spacing within rows (ft)	10.0	feet
# points per row	2	points/row
Spacing between rows (ft)	10.0	ft
# of rows	2	rows
Advective travel time bet. rows (days)	46	days
Number of points in grid	4	points
ORC-Adv application rate	5.0	lbs/foot
Total ORC-Adv required	200	lbs of ORC-Adv

Slurry Mixing Volume for Injections

Pounds per location	50	pounds
Buckets per location	2.0	buckets
Design solids content (20-40% by wt. for injections)	30%	
Volume of water required per hole (gal)	14	gallons
Total water for mixing all holes (gal)	42	gallons
Simple ORC-Adv Backfilling: min hole dia. for 67% slurry	3.7	inches
Feasibility for slurry injection in sand: ok up to 15 lb/ft	(ok)	
Feasibility for slurry injection in silt: ok up to 10 lb/ft	(ok)	
Feasibility for slurry injection in clay: ok up to 10 lb/ft	(ok)	

Project Summary			
Number of ORC-Adv delivery points (adjust as necessary for site)			3
ORC-Adv application rate in lbs/ft (adjust as necessary for site)			5.0
ORC-Adv bulk material for slurry injection (lbs)			150
Number of 25 lb ORC-Adv buckets			6.0
ORC-Adv bulk material cost ($/lb)		$	8.95
Cost for bulk ORC-Adv material		$	1,343
Shipping and Tax Estimates in US Dollars			
Sales Tax	rate: 0.00%	$	-
Total Material Cost		$	1,343
Shipping (call for amount)		$	-
Total Regenesis Material Cost		$	1,343

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: JWL	PAGE: 1 of 2
SUBJECT: NAS South Weymouth – Building 82 FS – Estimation of retardation factor		CHECKED BY:CAH	DATE: 03/06/12

Purpose: Estimate the retardation factor of TCE and 1,2-DCA to calculate contaminant velocity. Velocity will be used to evaluate injection of the entire source area or using a "barrier" approach.

Introduction:

Retardation factor is estimated from the following equation:

$R = 1 + (\rho/n)(K_d)$

Where:

R is the retardation factor, dimensionless
ρ is the bulk density of the soil on a dry basis, g/cm^3
n is the void space (fraction)
K_d is partition coefficient, L/kg = f_{oc} x K_{oc}
f_{oc} is fraction organic carbon
K_{oc} is the organic carbon partitioning coefficient

There were only a few measurements made of total organic carbon at Building 82 or Building 81. At Building 82, the few measurements are less than 1 % (0.01). The detection limit at Building 82 was lower. The results (in mg/kg) were 10,000 U, 500 U, 1,090 U, and 2,610. Thus, the concentration of organic carbon is low. For the calculation, the typical default value of f_{oc} used in the EPA Soil Screening Levels Guidance document of 0.002 (2,000 mg/kg) was used.

<u>TCE</u>

For TCE, K_{oc} = 160 L/kg. Thus, K_d = 160 * 0.002 = 0.32 L/kg.

ρ is assumed to be 100 lb/ft^3 (typical for sand).

100 lb/ft^3 x 454g/lb x ft^3/(0.3048 m)^3 x m^3/(100 cm)^3 = 1.6 g/cm^3

n is assumed to be 0.25 for the shallow overburden and 0.2 for the deep overburden, per the RI.

The largest part of the TCE plume is in the deep overburden, so:

$R_{deep} = 1 + (1.6/0.2)(0.32) = 3.6$

Per Table 3-7 of the RI, the lowest velocity in the deep overburden is 0.026 ft/day

Therefore, the TCE velocity in the deep overburden ($V_{TCE\ deep}$) is

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: LANT DIV	FILE No:	BY: JWL	PAGE: 2 of 2
SUBJECT: NAS South Weymouth – Building 82 FS – Estimation of retardation factor		CHECKED BY:CAH	DATE: 03/06/12

$V_{TCE\ deep}$ = 0.026/3.6 = 0.007 ft/day = 2.6 ft/year.

In 5 years, the distance would be 2.6 ft/yr x 5 years = 13 feet.

In the shallow overburden,

$R_{shallow}$ = 1 + (1.6/0.25)(0.32) = 3.1

Per Table 3-7 of the RI, the lowest velocity in the shallow overburden is 1.6 ft/day

Therefore, the TCE velocity in the shallow overburden ($V_{TCE\ shallow}$) is

$V_{TCE\ shallow}$ = 1.6/3.1 = 0.52 ft/day = 188 ft/year.

In 5 years, the distance would be 188 ft/yr x 5 years = 940 feet.

Because of the low velocity in the deep overburden, the barrier approach may require multiple injection events over a period of time depending on barrier spacing.

The barrier approach appears to be appropriate for one application within the shallow overburden.

<u>1,1-DCA</u>

For 1,1-DCA, K_{oc} = 30 L/kg. Thus, K_d = 30 * 0.002 = 0.06 L/kg.

All of the other assumptions for TCE apply.

In the shallow overburden,

$R_{shallow}$ = 1 + (1.6/0.25)(0.06) = 1.4

Per Table 3-7 of the RI, the lowest velocity in the shallow overburden is 1.6 ft/day

Therefore, the 1,1-DCA velocity in the shallow overburden ($V_{DCA\ shallow}$) is

$V_{DCAshallow}$ = 1.6/1.4 = 1.1 ft/day = 420 ft/year.

In 5 years, the distance would be 420 ft/yr x 5 years = 2,100 feet.

The barrier approach appears to be appropriate for the shallow overburden.

Alternative G-4

NAS SOUTH WEYMOUTH
BUILDNG 82 FS
ALTERNATIVE G-4
09/16/10

There are no process calculations for Alternative G-4. Refer to BIOCHLOR modeling results for natural attenuation.

Biochlor Modeling

Appendix

NAS South Weymouth
Building 82 Feasibility Study
Natural Attenuation Modeling
BIOCHLOR 2.2 Modeling

Problems: Determine the amount of time needed for the chlorinated ethene plume (TCE) to attenuate to below MCLs via natural attenuation after the center of the plume has been treated to 10 µg/L (Figure C-1).
Determine the amount of time needed for the chlorinated ethane plume (TCE) and the chlorinated ethane plume (111-TCA/ 11-DCE) to attenuate to below MCLs or PRGs via natural attenuation, only.

Model Selection: BIOCHLOR Natural Attenuation Decision Support System, Version 2.2, developed by the USEPA Center for Subsurface Modeling Support, was used as a screening model to simulate remediation by natural attenuation (NA) of select dissolved solvents in groundwater beneath the Building 82 Site. The software, is based on the Domenico analytical solute transport model, has the ability to simulate 1-D advection, 3-D dispersion, linear adsorption, and biotransformation via reductive dechlorination.

Input Data:

Data Type	***Parameter***	***Value***	***Source***
Hydrogeology	Seepage Velocities (Vs)	Shallow: 580 to 832 ft/yr	Draft RI report
		Deep: 9.53 to 13.6 ft/yr	Draft RI report
Dispersion	Longitudinal Dispersivity (alpha x)	15	Plume length of 350- ft and Xu/Eckstein, 1995 relationship
	Transverse Dispersivity (alpha y)	1.5	Gelhar, 1992 relationship of alpha y/ alpha x = 0.1
	Vertical Dispersivity	0	Conservative estimate

Adsorption	Chemical Retardation Factors (R)	TCE Shallow: 2.50 TCE Deep: 2.87 111-TCA: 2.87	Literature values
	Common Retardation Factors: Bulk density: Foc: Koc: Effective porosity	 1.6 Kg/L 0.0018 TCE: 130 L/kg 111-TCA: 426 L/kg Shallow: 0.25 Deep: 0.20	 Estimate Estimate Literature value Literature value Draft final RI report Draft final RI report
General	Modeled Area Length	Shallow (TCE): 330 feet Deep(TCE): 540 feet 111-TCA: 300 feet	Distance from source (GP-K10) to receptor (drainage) Distance from source (GP-K13) to receptor (drainage) Conservative estimate
	Modeled Area Width	Shallow (TCE): 150 feet Deep (TCE): 300 feet 111-TCA: 300 feet	Width of plume above 1 µg/L Width of plume above 1 µg/L Conservative estimate
Source Data	Source thickness	20 feet	Based upon hydrogeology and contaminant distribution in draft final RI report

	Source Widths	Model 1 (TCE): Zone 1: 70 feet Zone 2: 140 feet Zone 3: 245 feet Model 2 (TCE): Zone 1: 28 feet Zone 2: 65 feet Zone 3: 140 feet Model 3 (TCE): Zone 1: 50 feet Zone 2: 70 feet Model 4: 111-TCA: 15 ft	Draft final RI report Figure C-1 Figurec C-2 Figure C-3 Figure C-4
	Source Concentrations (µg/L)	Model 1 (TCE): Zone 1: 10 (remediated) Zone 2: 9 (MW-10D) Zone 3: 3.7 (GP-C04) Model 2 (TCE): Zone 1: 25 (GP-K09) Zone 2: 18 (GP-K07) Zone 3: 9 (MW-10D) Model 3 (TCE): Zone 1: 5 (GP-K09) Zone 2: 1.1 (GP-K10) Model 4: 111-TCA: 360 (GP-A01) 11-DCA:99 (GP-A01) CA: 1 (GP-A01)	Draft final RI report 2006 data 2006 data 2006 data 2009 data 2009 data 2006 data 2009 data 2009 data 2006 data 2006 data 2006 data
	Source degradation term (Ks) (/ year	TCE: 0.029 to 2.96/ year 111-TCA: 0.2 to 2 / year	Conc. Vs. distance regression and calculations (see below)
Target Concentration	MCL (µg/L)	TCE: 5 111-TCA: 200	USEPA

Procedure:

- BIOCHLOR was used to estimate the amount of time it would take for natural attenuation to reduce the concentration of TCE and 111-TCA in groundwater to below their respective MCLs
- BIOCHLOR was used to estimate the amount of time it would take for natural attenuation to reduce the concentration of TCE in groundwater to below the MCL, assuming the center of the plume was remediated to 10 µg/L (Figure C-1).
- Seepage velocities for shallow and deep overburden (from the Draft RI report) were entered directly in BIOCHLOR. The range of seepage velocities were used to determine a range of cleanup times.
- Retardation factors were based upon literature values
- General Data.
  - Modeled area length (TCE plume) was based upon the distance from the source and the receptor.
  - Modeled area width (TCE plume) was based upon the width of the plume.
  - Model A was based upon the assumption that the source area was treated down to 10 ug/L within the area marked on Figure C-1 for the deep overburden.
  - Model B was based upon natural attenuation alone for the deep overburden (Figure C-2).
  - Model C was based upon natural attenuation alone for the shallow overburden (Figure C-3). (Note: concentration already at or below the MCL).
  - Because the size of the 111-TCA/ 11-DCA plume is so very small (it was only detected in one location), the modeled area length and width of the chlorinated ethane plume was conservatively estimated at 300 feet wide and 300 feet long. (Figure C-4)
  - Simulation time was varied in order to bring the predicted concentration below MCLs/ PRGs.

- Source data (thickness, widths and concentrations) were obtained from the draft final RI report.

Source Degradation Term Calculations and Biochlor Results:

- Source degradation term (Ks) for TCE was calculated, for the range of seepage velocities in both shallow and deep overburden, by the following method:
  - Assume: the sorbed source has been completely removed so that the estimate of the degradation term can be made by plotting the concentration of TCE versus distance from the source and doing a linear regression of the data (Figure C-5), and the following analysis:

    a) contaminant velocity (Vc)=seepage velocity (Vs)/retardation factor (R)

b) Ks = the slope of the best fit line in the above regression x Vc

- The source degradation term was then used in the Biochlor model to estimate the time required to meet MCLs, as shown on the following table:

TCE Plume				
Unit	*Vs (ft/year)*	*Vc (ft/year)*	*Ks (/year)*	*Time*
Deep Overburden				
Model A (remediation)	9.5	3.3	0.029	24 years[1]
	13.6	4.7	0.042	17 years
Model B (natural attenuation)	9.5	3.3	0.029	56 years[2]
	13.6	4.7	0.042	39 years
Shallow Overburden				
Model C (natural attenuation)	580	232	2.06	< 1 year[3]
	832	332.8	2.96	< 1 year

[1] model input and output shown as attachment Run 1
[2] model input and output shown as attachment Run 2
[3] model input and output shown as attachment Run 3

- 111-TCA was only detected at one location (GP-A01). The highest concentration of both 111-TCA and its breakdown product 11-DCA were detected in the shallow overburden from a depth of 9 to 12 feet. The concentration of 111-TCA in deep overburden is already well below MCLs. The highest concentrations were used in the source area for the modeling. Because the ethanes were only detected in one location, the distance versus concentration technique could not be used to determine the source degradation term for 111-TCA. Source degradation term for 111-TCA was estimated using the source degradation term calculated for TCE (2/year). In order to be conservative, a one order of magnitude safety factor was put on this estimated Ks for 111-TCA and it was also modeled as 0.2/ year.

- The two source degradation rates for 111-TCA were then used in Biochlor to estimate the time required to meet 111-TCAs MCL and 11-DCAs PRG, as shown in the following table.

111-TCA Plume			
Unit	*Vs (ft/year)*	*Ks (/year)*	*Time*
Shallow Overburden			
	580	2	< 1 year
	580	0.2	3 years[4]
	832	2	< 1 year
	832	0.2	3 years

[4] model input and output shown as attachment Run 4

Results:

The results of modeling described herein indicate that the TCE plume will be degraded to below its MCLs by remediation followed by NA in between about 17 and 24 years. These results were based upon many conservative assumptions including the size and concentration of the plumes after treatment. One conservative run is attached here for documentation. Run 1 shows the input and output for the deep overburden TCE plume after remediation.

The TCE plume in the deep overburden will be degraded to below its MCL by NA alone in between about 39 and 56 years. The TCE plume in the shallow overburden will be degraded to below its MCL by NA alone in less than 2 months. The 111-TCA plume will be degraded to below its MCL by NA alone in between less than a year to 3 years. 11-DCA, a breakdown product of 111-TCA will be degraded below its PRG of 99 µg/L along with the degradation of the 111-TCA. These results were based upon many conservative assumptions including the size and concentration of the plumes. Three conservative BIOCHLOR modeling runs are attached here for documentation. Attachment Run 2 shows the input and output for the deep overburden TCE plume (no remediation). Attachment Run 3 shows the input and results for the shallow overburden TCE plume natural attenuation. Attachment Run 4 shows the modeling input and results for the modeling of the shallow overburden 111-TCA plume.

Uncertainty:

It is important to note that BIOCHLOR model tool has several inherent limitations. Because the BIOCHLOR model averages the effects of retardation on contaminant transport and because only a single, non-reversible reaction chain for degradation can be modeled, uncertainty is inherent to the results of the modeling.

In addition, data limitations observed during modeling add additional uncertainty to the results of the modeling. One data limitation is the lack of concentration versus time data in the source area(s). Concentration versus time data would have been useful in the estimate of a source degradation rate. Rather than using the concentration versus distance method outlined herein, the concentration versus time method of estimating Ks would have been more accurate.

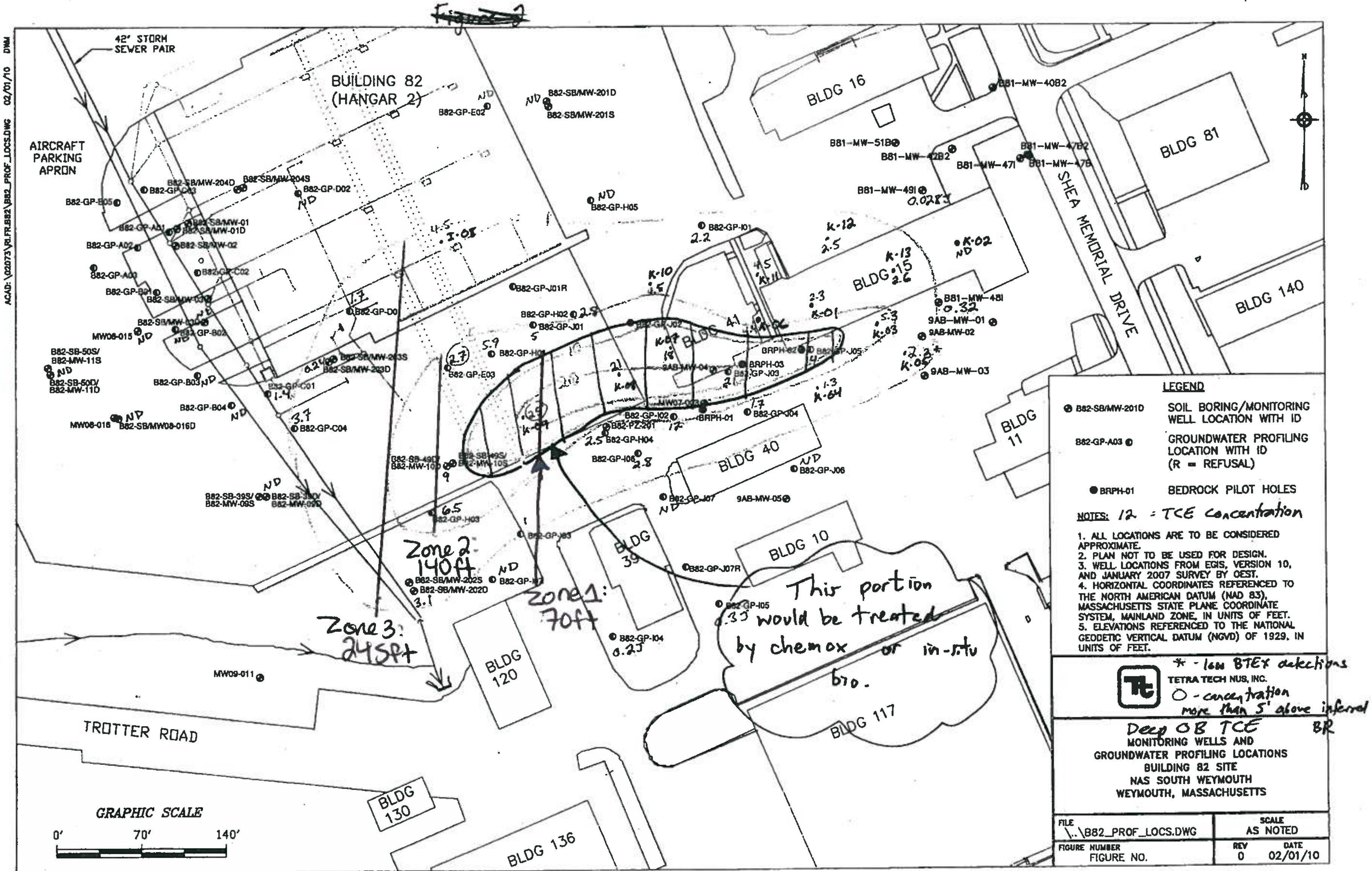
Due to the uncertainties in the modeling process, the approximations outlined herein should be considered as part of the conceptualization of the process of remediation of the groundwater contamination. These simulations only provide an estimate of the impact of chlorinated ethane and chlorinated ethane degradation in the cleanup of the groundwater.

References:

Gelhar, L.W., C. Welty, and K.R. Rehfeldt, 1992, A Critical Review of Data on Field-Scale Dispersion in Aquifers, Water Resources Research, 28(7):1955-1974.

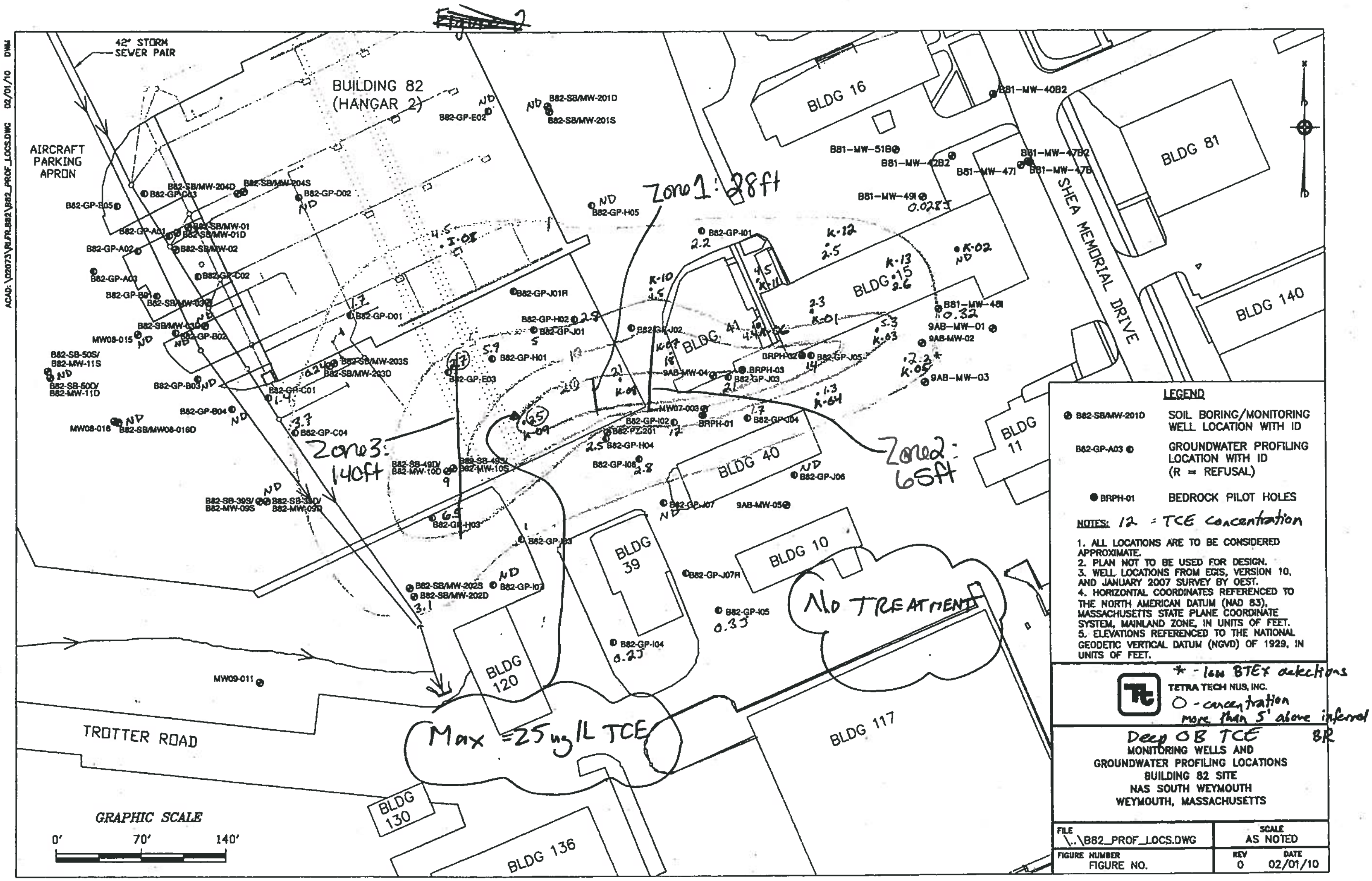
Xu, Moujin and Y. Eckstein, 1995, “Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Scale,” Journal of Ground Water, Vol. 33, No. 6, pp 905-908.

USEPA. March 2002. BIOCHLOR Natural Attenuation Decision Support System,Version 2.2.



A - Treatment of 10 ug/L plume.

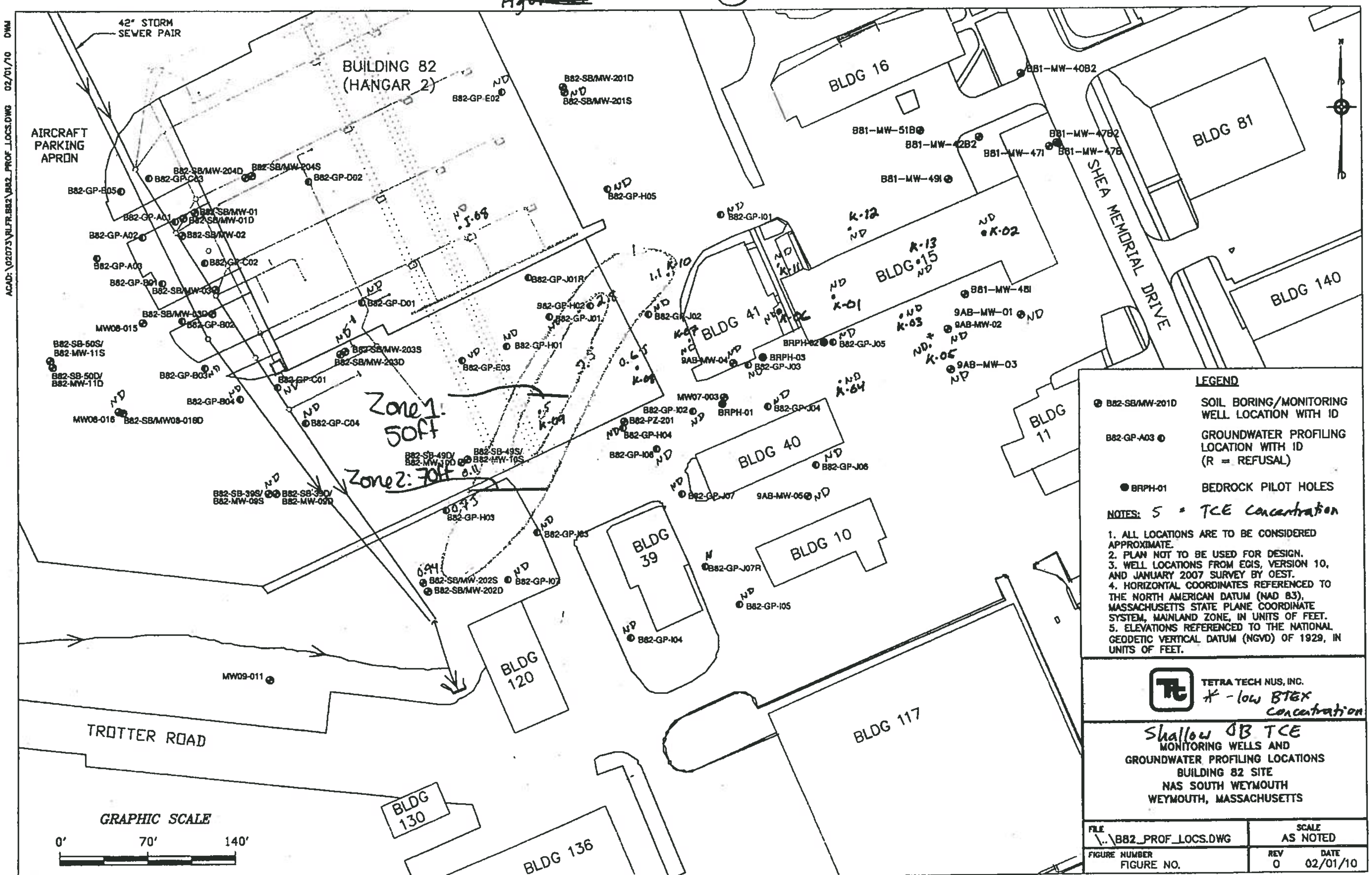
Figure C-1



B. MNA only.

Figure C-2

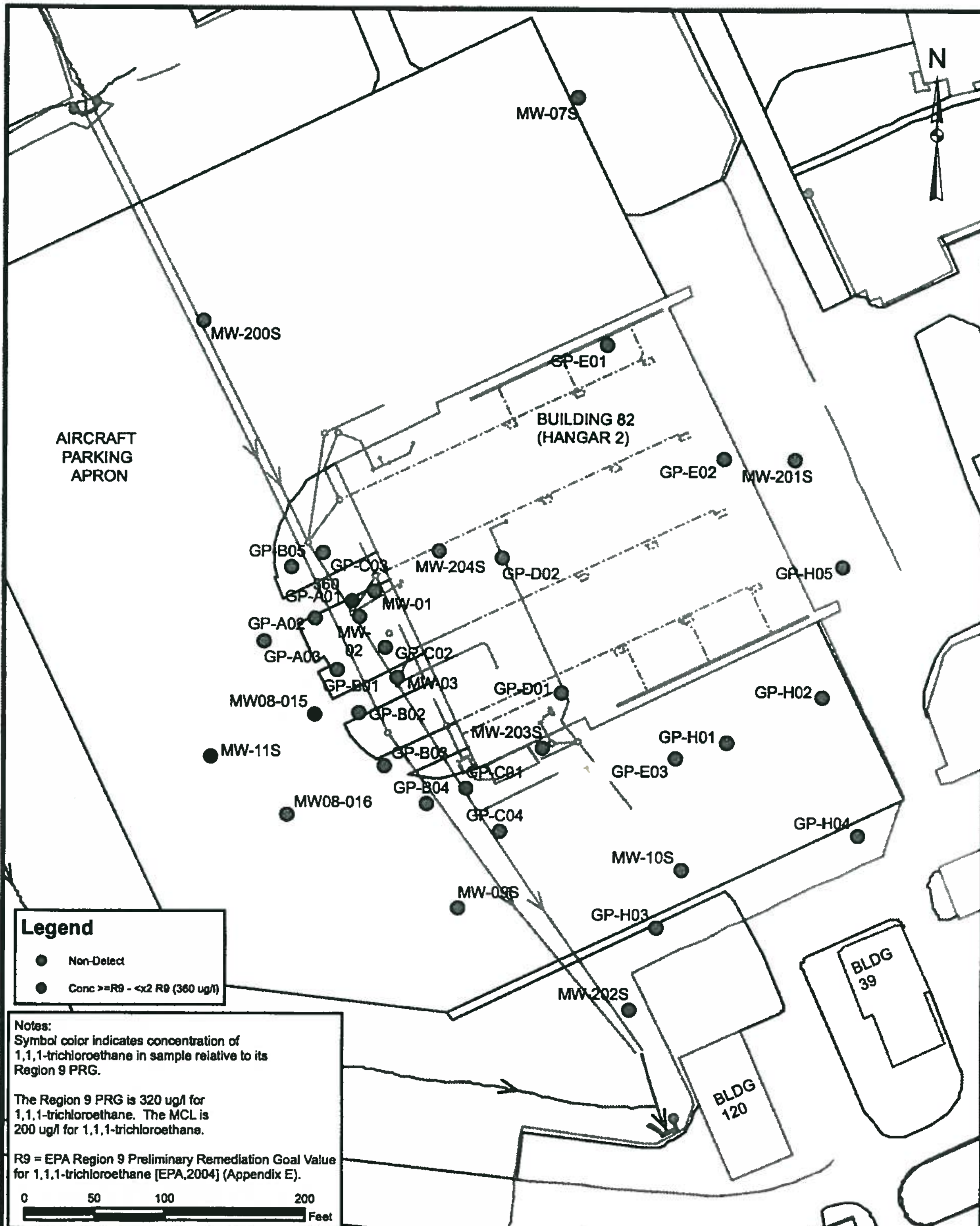
C



C - The Max concentration is 5 ug/L. Although less than 10 ug/L, Incidental treatment may be applied.

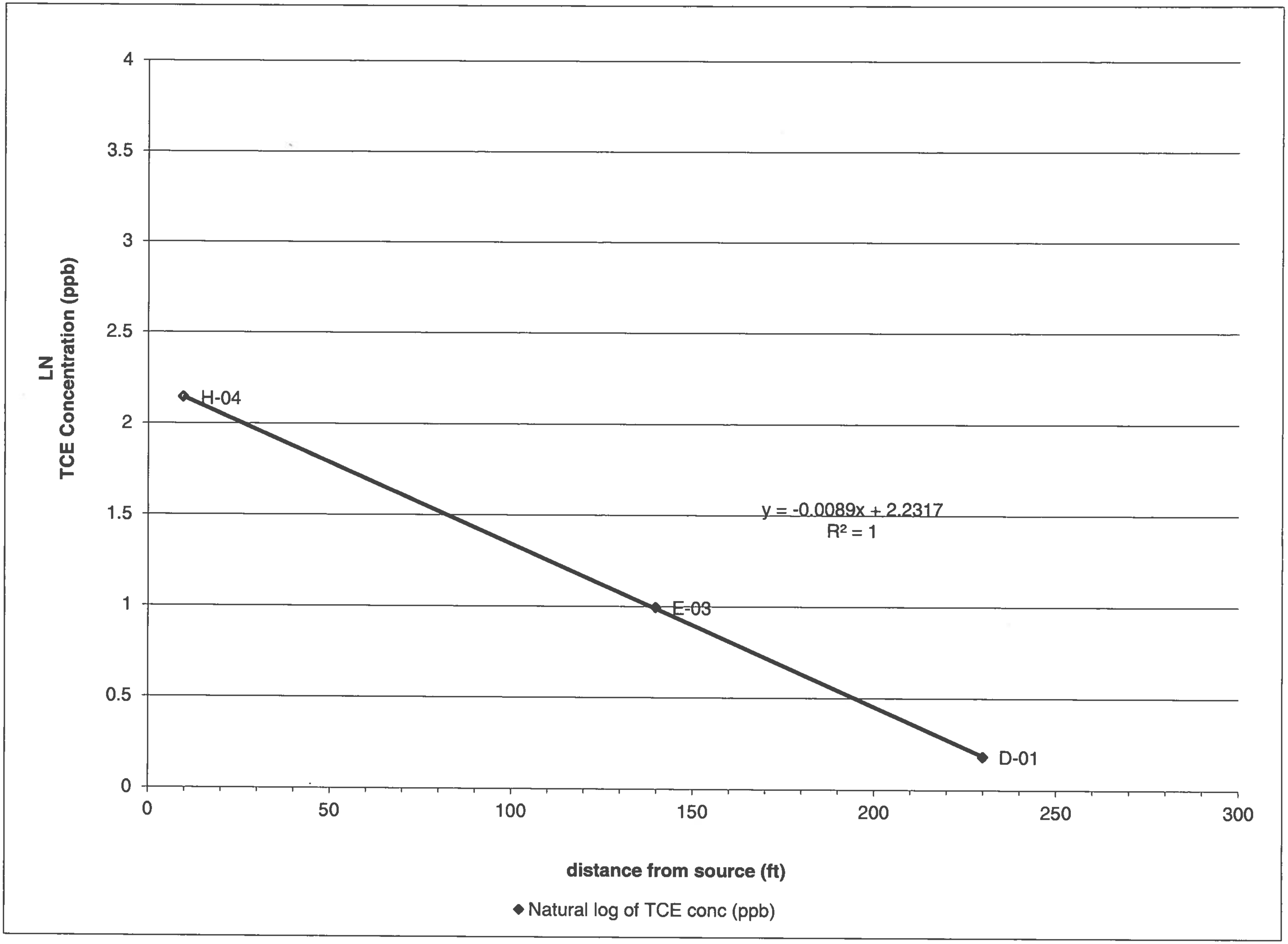
Figure C-3

I:\02173\RI.DF.B82\FIG4-30.MXD 07/26/09 DWM



Tetra Tech NUS, Inc.	1,1,1-TRICHLOROETHANE CONCENTRATIONS IN SHALLOW GROUNDWATER REMEDIAL INVESTIGATION REPORT BUILDING 82 SITE NAS SOUTH WEYMOUTH WEYMOUTH, MASSACHUSETTS	SCALE: AS NOTED FILE: \.\FIG4-30.MXD REV: 0 DATE: 07/26/09 FIGURE NUMBER: FIGURE NO. 4-30

Figure C-4



4
3.5
3
2.5
2
1.5
1
0.5
0
0
50
100
150
200
250
300
LN
TCE Concentration (ppb)
H-04
E-03
D-01
y = -0.0089x + 2.2317
R² = 1
distance from source (ft)
◆ Natural log of TCE conc (ppb)

Figure C-5

Run 1

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

NAS South Weymouth
Building 82
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes (selected) / Ethanes

1. ADVECTION

Seepage Velocity*	Vs	9.5	(ft/yr)
or			
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	15	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.6	(kg/L)
FractionOrganicCarbon, foc	1.8E-3	(-)

Partition Coefficient	Koc		R	
PCE	426	(L/kg)	7.13	(-)
TCE	130	(L/kg)	2.87	(-)
DCE	125	(L/kg)	2.80	(-)
VC	30	(L/kg)	1.43	(-)
ETH	302	(L/kg)	5.35	(-)

Common R (used in model)* = 2.87

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1		λ (1/yr)	half-life (yrs)	Yield
PCE → TCE		2.000		0.79
TCE → DCE		1.000		0.74
DCE → VC		0.700		0.64
VC → ETH		0.400		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	24	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	540	(ft)
Zone 1 Length*	540	(ft)
Zone 2 Length*	0	(ft)

L W
Zone 2= L - Zone 1

6. SOURCE DATA

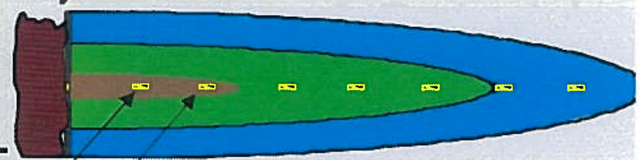
TYPE: Decaying Spatially-Varying

Source Options

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

Source Thickness in Sat. Zone* 20 (ft)

	Y1	Y2	Y3	
Width* (ft)	70	140	245	
Conc. (mg/L)*	C1	C2	C3	k_s* (1/yr)
PCE				0.029
TCE	.01	0.009	0.004	0.029
DCE				0.029
VC				0.029
ETH				0.029



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	560	650	930	1085						
Date Data Collected	1998										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

SEE

Restore

Paste

RESE

Run 1

Start Here → PCE / **TCE** (selected) / DCE / VC / ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

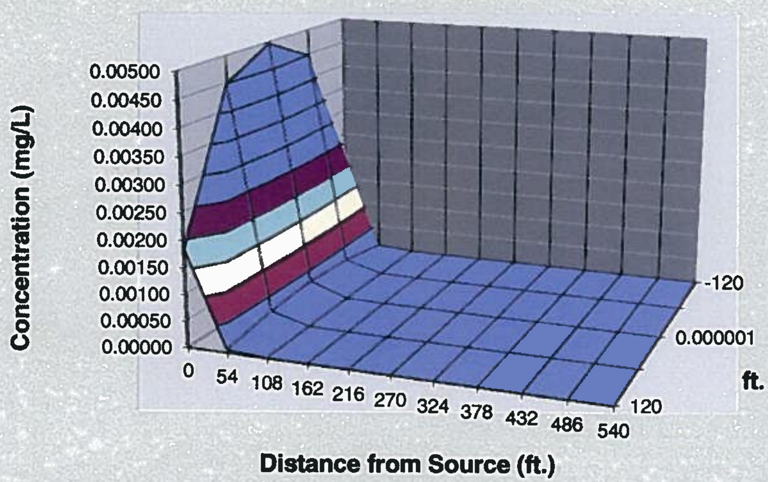
Transverse Distance (ft) ↓ | *Distance from Source (ft)*

	0	54	108	162	216	270	324	378	432	486	540
120	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-60	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-120	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	3.1E+0	1.5E-1	8.0E-3	3.8E-4	1.1E-5	1.4E-7	6.5E-10	1.0E-12	5.1E-16	7.8E-20	3.7E-24

Show No

Show

Time: 24 yr   Target Level: **0.005** mg/L   Displayed Model: **Biotransformation**   Displayed Compound: **TCE**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon	Plume Mass If No Degradation	0.0 (Kg)
	- Plume Mass If Biotransformation/Production	0.0 (Kg)
	Mass Removed	0.0 (Kg)
If "Can't Calc.", make model area longer	**% Biotransformed =**	**+73.7%**
	% Change in Mass Rate =	**100.0 %** (source to edge)

See acre-ft	Current Volume of Ground Water in Plume	0.00 MGal
	Flow Rate of Water Through Source Area	0.000 MGD

Compare to Pump and Treat

Pumping Rate	(gpm)
# Pore Volumes Removed Per Yr.	#DIV/0!
# Pore Volumes to Clean-Up	
Clean-Up Time	(yr)

Plot All Data   Plot Data > Target   **Mass HELP**   **To Centerline**   **Return to Input**

Run 2

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

NAS South Weymouth
Building 82
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	9.5	(ft/yr)
or			
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	15	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.6	(kg/L)
FractionOrganicCarbon, foc	1.8E-3	(-)

Partition Coefficient

	Koc		R	
PCE	426	(L/kg)	7.13	(-)
TCE	130	(L/kg)	2.87	(-)
DCE	125	(L/kg)	2.80	(-)
VC	30	(L/kg)	1.43	(-)
ETH	302	(L/kg)	5.35	(-)

Common R (used in model)* = 2.87

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	2.000		0.79
TCE → DCE	1.000		0.74
DCE → VC	0.700		0.64
VC → ETH	0.400		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	540	(ft)
Zone 1 Length*	540	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

L W

6. SOURCE DATA TYPE: Decaying Spatially-Varying

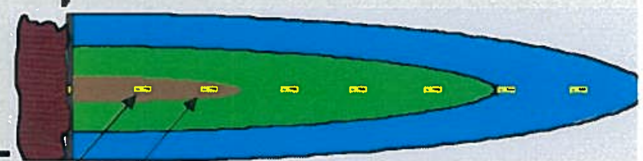
Source Options

Source Thickness in Sat. Zone* 20 (ft)

	Y1	Y2	Y3
Width* (ft)	28	65	140

Conc. (mg/L)*	C1	C2	C3	k_s* (1/yr)
PCE				0.029
TCE	.025	0.018	0.009	0.029
DCE				0.029
VC				0.029
ETH				0.029

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	560	650	930	1085						
Date Data Collected	1998										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

SEE

Restore

Paste

RESE

Run 2

Start Here → PCE ◉ TCE DCE VC ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Transverse Distance (ft) / *Distance from Source (ft)*

	0	54	108	162	216	270	324	378	432	486	540
120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-60	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	1.5E+0	7.4E-2	3.9E-3	2.1E-4	1.2E-5	6.6E-7	3.6E-8	1.9E-9	8.5E-11	3.0E-12	7.4E-14

Show No

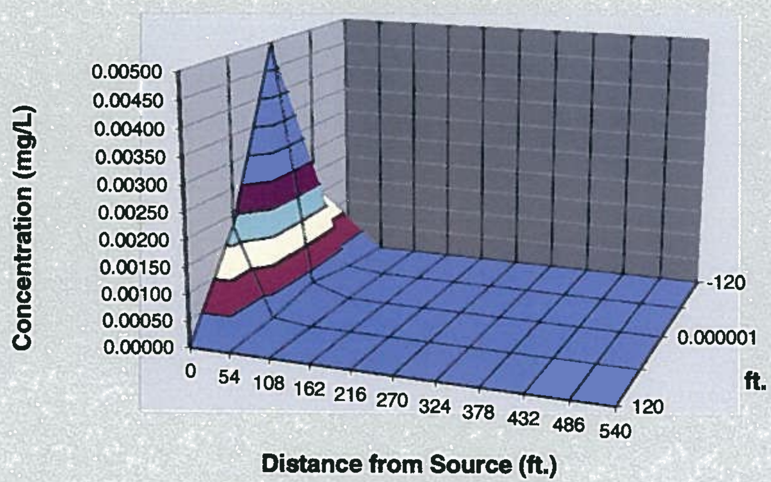
Show

Time: 55.5 yr

Target Level: **0.005** mg/L

Displayed Model: **Biotransformation**

Displayed Compound: **TCE**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon

Plume Mass If No Degradation	0.1	*(Kg)*
- Plume Mass If Biotransformation/Production	0.0	*(Kg)*
Mass Removed	0.1	*(Kg)*

If "Can't Calc.", make model area longer

% Biotransformed = **+92.4%**

% Change in Mass Rate = **100.0 %** (source to edge)

See acre-ft

Current Volume of Ground Water in Plume	0.00	*MGal*
Flow Rate of Water Through Source Area	0.000	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.	#DIV/0!	
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Plot All Data | Plot Data > Target | **Mass HELP** | **To Centerline** | **Return to Input**

Run3

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2

Excel 2000

NAS South Weymouth

Building 82

Run Name

Data Input Instructions:

115 — 1. Enter value directly....or

or — 2. Calculate by filling in gray

0.02 — cells. Press Enter, then C

(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes (selected) / Ethanes

1. ADVECTION

Seepage Velocity*	Vs	580.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	15	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.6	(kg/L)
FractionOrganicCarbon, foc	1.8E-3	(-)

Partition Coefficient	Koc		R	
PCE	426	(L/kg)	5.91	(-)
TCE	130	(L/kg)	2.50	(-)
DCE	125	(L/kg)	2.44	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.48	(-)

Common R (used in model)* = 2.50

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

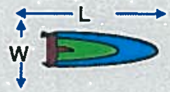
Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	2.000		0.79
TCE → DCE	1.000		0.74
DCE → VC	0.700		0.64
VC → ETH	0.400		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	0	(yr)
Modeled Area Width*	150	(ft)
Modeled Area Length*	330	(ft)
Zone 1 Length*	330	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Spatially-Varying

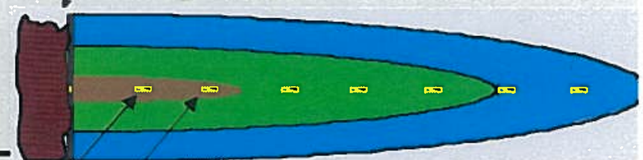
Source Options

Source Thickness in Sat. Zone* 20 (ft)

	Y1	Y2	Y3
Width* (ft)	50	70	

Conc. (mg/L)*	C1	C2	C3	k_s* (1/yr)
PCE				2.06
TCE	.005	0.001		2.06
DCE				2.06
VC				2.06
ETH				2.06

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

2.06

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)										
TCE Conc. (mg/L)										
DCE Conc. (mg/L)										
VC Conc. (mg/L)										
ETH Conc. (mg/L)										
Distance from Source (ft)	0	560	650	930	1085					
Date Data Collected	1998									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

RUN ARRAY

Help

Restore

RESE

SEE

Paste

Run 3

Start Here → ○ PCE ◉ TCE ○ DCE ○ VC ○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Transverse Distance (ft) ↓ ***Distance from Source (ft)***

	0	33	66	99	132	165	198	231	264	297	330
60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	0.004	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-30	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	4.0E+1	2.7E+1	4.7E+0	2.0E-1	1.9E-3	4.0E-6	1.9E-9	1.1E-13	0.0E+0	0.0E+0	0.0E+0

Show No

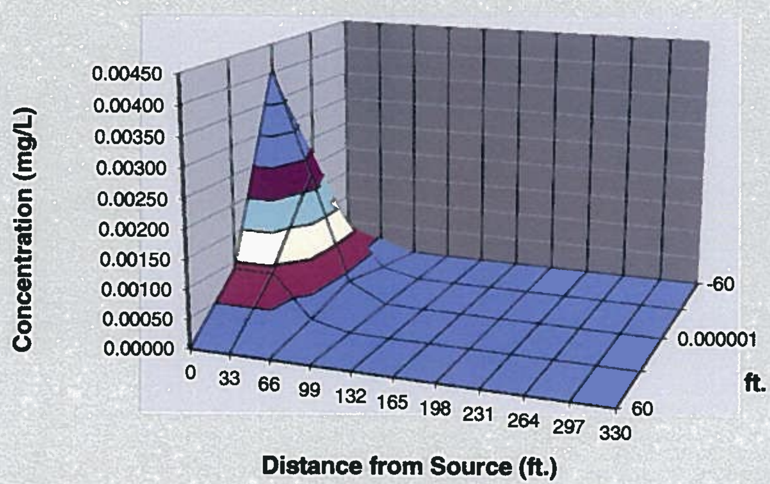
Show

Time: 0.1 yr

Target Level: **0.005** mg/L

Displayed Model: **Biotransformation**

Displayed Compound: **TCE**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallon

Plume Mass If No Degradation	0.0	*(Kg)*
- Plume Mass If Biotransformation/Production	0.0	*(Kg)*
Mass Removed	0.0	*(Kg)*
% Biotransformed =	**+1.5%**	
% Change in Mass Rate =	**100.0 %**	(source to edge)

If "Can't Calc.", make model area longer

See acre-ft

Current Volume of Ground Water in Plume	0.00	*MGal*
Flow Rate of Water Through Source Area	0.000	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.	#DIV/0!	
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Plot All Data | Plot Data > Target | **Mass HELP** | **To Centerline** | **Return to Input**

Run 4

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

S Weymouth NAS
Building 82
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ○ Ethanes ◉

1. ADVECTION

Seepage Velocity*	Vs	580.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	15	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.6	(kg/L)
FractionOrganicCarbon, foc	1.8E-3	(-)

Partition Coefficient	Koc		R	
TCA	426	(L/kg)	7.13	(-)
DCA	130	(L/kg)	2.87	(-)
CA	125	(L/kg)	2.80	(-)

Common R (used in model)* = 2.87

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

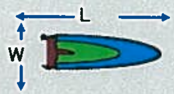
Zone 1	λ (1/yr)	half-life (yrs)	Yield
TCA → DCA	2.000		0.74
DCA → CA	1.000		0.65
CA → Ethane	0.700		0.47
	0.000		0.00

Zone 2	λ (1/yr)	half-life (yrs)
TCA → DCA	0.000	
DCA → CA	0.000	
CA → Ethane	0.000	
	0.000	

λ HELP

5. GENERAL

Simulation Time*	3	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	300	(ft)
Zone 1 Length*	300	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA TYPE: Decaying Single Planar

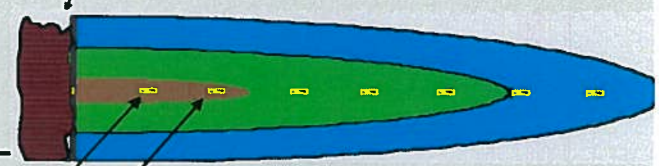
Source Options

Source Thickness in Sat. Zone* 20 (ft)

	Y1
Width* (ft)	15

Conc. (mg/L)*	C1	k_s* (1/yr)
TCA	.36	0.2
DCA	.099	0.2
CA	.001	0.2

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

TCA Conc. (mg/L)											
DCA Conc. (mg/L)											
CA Conc. (mg/L)											
Distance from Source (ft)	0	560	650	930	1085						
Date Data Collected	1998										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

Run 4

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Start Here → ◉ TCA ○ DCA ○ CA ○ ○

Transverse Distance (ft) ↓ / *Distance from Source (ft)*

	0	30	60	90	120	150	180	210	240	270	300
120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.003
0	0.198	0.105	0.073	0.056	0.046	0.038	0.033	0.028	0.025	0.022	0.019
-60	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.003
-120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	5.3E+2	1.1E+3	7.8E+2	6.1E+2	5.0E+2	4.3E+2	3.8E+2	3.4E+2	3.1E+2	2.9E+2	2.6E+2

Show No Degradation

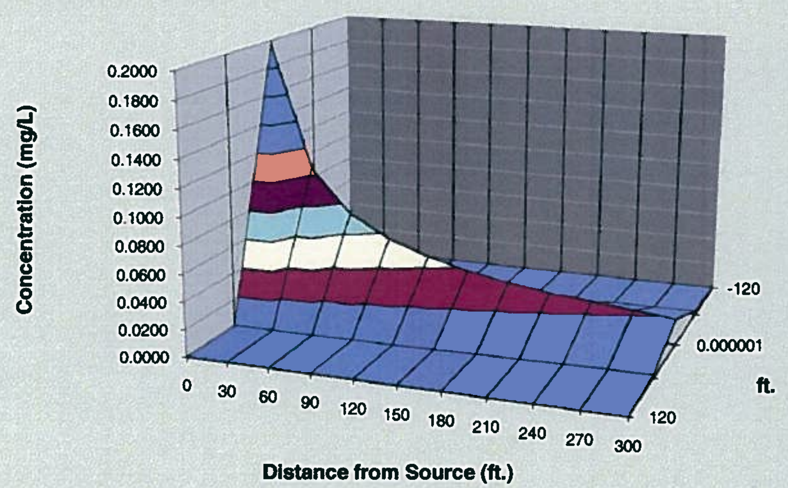
Show Biotransformation

Time: 3 yr

Target Level: **0.200** mg/L

Displayed Model: **Biotransformation**

Displayed Compound: **TCA**



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	0.5	*(Kg)*
- Plume Mass If Biotransformation/Production	0.3	*(Kg)*
Mass Removed	0.2	*(Kg)*
% Biotransformed =	**+32.9%**	
% Change In Mass Rate =	**50.4 %**	(source to edge)

If "Can't Calc.", make model area longer

See acre-ft

Current Volume of Ground Water in Plume	Can't Calc.	*MGal*
Flow Rate of Water Through Source Area	0.001	*MGD*

Compare to Pump and Treat

Pumping Rate		*(gpm)*
# Pore Volumes Removed Per Yr.		
# Pore Volumes to Clean-Up		
Clean-Up Time		*(yr)*

Plot All Data | Plot Data > Target | Mass HELP | To Centerline | Return to Input

APPENDIX E

SUSTAINABLE REMEDIATION EVALUATION

APPENDIX E-1 ENVIRONMENTAL FOOTPRINT REPORT

APPENDIX E

Environmental Footprint Evaluation
Feasibility Study
Building 82
Naval Air Station South Weymouth
Weymouth, Massachusetts
March 2012

OBJECTIVE

This Environmental Footprint Evaluation of remedial alternatives is provided as an Appendix to the Feasibility Study (FS) for Building 82 located at the Naval Air Station South Weymouth located in Weymouth, MA. The purpose of the footprint evaluation is to assess the environmental impacts of the four remedial alternatives using the metrics of greenhouse gas (GHG) and criteria pollutant emissions, energy use, water consumption, and worker safety. The results of this footprint evaluation are intended to provide additional information for consideration during remedy selection, design, and to enhance the understanding of the environmental impacts throughout the remedy life-cycle for each of the proposed alternatives.

POLICY BACKGROUND

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout (NAVFAC, 2010a).

In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling, etc. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009 DOD issued a policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the Department of the Navy (DON) issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (NAVFAC, 2010), which includes environmental footprint evaluations as part of the traditional DON optimization review process for remedy selection, design, and remedial action operation. In August 2010, the Naval Facilities Engineering Command (NAVFAC) issued policy requiring use of the SiteWise™ tool to perform environmental impact reviews as part of all Feasibility Studies. As such, this environmental footprint evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of reducing the environmental impact of remedial action at OU9, Portsmouth Naval Shipyard.

Applying the DON optimization concepts with an environmental footprint evaluation within the remedy selection and design phases allows for the following benefits:

- Determining factors in each remedial alternative with the greatest environmental impacts and gathering insight into how to reduce these impacts;
- Evaluating remedial alternatives with optimized or reduced environmental footprints in conjunction with other selection criteria;
- Designing and implementing a more robust remedy while balancing the impact to the environment; and
- Ensuring efficient, cost-effective and sustainable site closeout.

EVALUATION TOOLS

This evaluation was performed using a hybrid model of the Navy's SiteWise™ tool supplemented with Tetra Tech developed model as appropriate for some site-specific items.

SiteWise™ is a life-cycle footprint assessment tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle. SiteWise™ assesses the environmental footprint of a remedial alternative/technology using a consistent set of metrics. The assessment is conducted using a building block approach, where each remedial alternative is first broken down into modules that follow the phases for most remedial actions, including remedial investigation (RI), remedial action construction (RA-C), remedial action operation (RA-O), and long-term monitoring (LTM). Once broken down by remedial phase, the footprint of each phase is calculated. The phase-specific footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the footprint assessment and facilitates the identification of specific impact drivers that contribute to the environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site, transportation of personnel; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

GSRx builds off of SiteWise™ and allows for a flexible, detailed analysis, particularly for materials and equipment use. GSRx was used to account for materials and activities not readily input into SiteWise™

and where equipment usage assumptions built into SiteWise™ were not consistent with site-specific requirements.

ENVIRONMENTAL FOOTPRINT EVALUATION FRAMEWORK AND LIMITATIONS

The environmental footprint evaluation performed for the FS of Building 82 at NAS South Weymouth considered life-cycle quantitative metrics for global warming potential (through greenhouse gas emissions), criteria air pollutant emissions (through NO_X, SO_X and PM_{10} emissions), energy consumption, water usage, and worker safety.

Life cycle impacts were calculated for energy consumption, emissions of GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) and criteria pollutants (nitrogen oxides [NO_x], sulfur oxides [SO_x] and particulate matter [PM_{10}]), water usage, and energy consumption, and worker safety.

Life cycle inventory inputs in SiteWise™ were divided into four categories – 1) materials production; 2) transportation of personnel, materials and equipment; 3) equipment use and miscellaneous; and 4) residual handling and disposal. Cost estimates from the RI/FS and design calculations were used as a basis for inventory quantities and related assumptions. Emission factors, energy consumption, and water usage data were correlated to material quantities, equipment, transportation distances, and installation time frames in order to calculate life-cycle emissions, energy consumption, water usage, and worker safety. Default SiteWise™ emission, energy usage, water consumption, and worker fatality and accident risk factors were utilized.

Although GSRx was used to minimize limitations resulting within SiteWise™, elimination of all limitations was not possible while using a hybrid model of SiteWise™ and GSRx. For example, several materials and construction equipment inventoried were input into GSRx and these impacts were incorporated into SiteWise™ within the “Equipment Use and Miscellaneous” sector. This sector in SiteWise™ does not differentiate into the specific equipment usage or material consumption items that are input in GSRx, but rather are considered miscellaneous items. However, impact drivers for items input in GSRx can be identified and evaluated directly within the respective GSRx evaluation and output summary sheets. In addition, worker safety results in general do not include worker safety related to equipment usage that was input within GSRx because GSRx was not developed to evaluate worker safety.

EVALUATION RESULTS

The following are the alternatives that were analyzed with SiteWise™ and GSRx for the Building 82 NAS South Weymouth FS:

- Alternative 2: In-Situ Chemical Oxidation, MNA, LUCs
- Alternative 2a: Full Plume In-Situ Chemical Oxidation, Monitoring, LUCs
- Alternative 3: Enhanced Bioremediation, MNA, LUCs
- Alternative 4: Natural Attenuation with Monitoring/LUCs

The following sections summarize the relative environmental impacts and primary impact drivers for the four alternatives and their respective metrics. In addition, the attachment includes the inventory and output sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the footprint evaluation attachments (Appendix E-2 and E-3), provides detailed information on the contribution to each metric from each phase of the remedial process (RI, RAC, RAO, and LTM) and for each respective input category (materials production, transportation, equipment usage, etc). Further inspection of related inventory sheets provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously. The environmental impacts of the alternatives analyzed are summarized quantitatively in Table E1.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure E1 shows the overall GHG emissions of each of the alternatives analyzed; the x-axis represents the four alternatives evaluated and the y-axis represents the GHG emissions in metric tons of CO_2e.

The total amount of GHG emissions from Alternative G-2 is 4,735 metric tons of CO_2e. The main contributor the GHG emissions is the production of hydrogen peroxide used as the Fenton's Reagent during treatment; the amount of emissions resulting from this activity is 4,667 metric tons of CO_2e, corresponding to 98.5 percent of the total GHG emissions. The laboratory analytical services is the activity with the second highest contribution to GHG emissions, 36.7 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 0.8 percent of the total GHG emissions. Transportation of personnel is the activity with the third highest contribution to the CO_2e emissions, with 10.7 metric tons, corresponding to 0.2 percent of the total emissions.

The total amount of GHG emissions from Alternative G-2a is 8,590 metric tons of CO_2e. The main contributor the GHG emissions is the production of hydrogen peroxide used as the Fenton's Reagent during treatment; the amount of emissions resulting from this activity is 8,495 metric tons of CO_2e, corresponding to 98.9 percent of the total GHG emissions. The laboratory analytical services is the activity with the second highest contribution to GHG emissions, 46.1 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 0.5 percent of the total GHG emissions. Production of PVC is the activity with the third highest contribution to the CO_2e emissions, with 14.3 metric tons, corresponding to 0.17 percent of the total emissions.

The total amount of GHG emissions from Alternative G-3 is 115 metric tons of CO_2e. The main contributor the GHG emissions is the production of vegetable oil used as the EOS during treatment; the amount of emissions resulting from this activity is 52.4 metric tons of CO_2e, corresponding to 45.6 percent of the total GHG emissions. The laboratory analytical services is the activity with the second highest contribution to GHG emissions, 37 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 32.2 percent of the total GHG emissions. Transportation of personnel is the activity with the third highest contribution to the CO_2e emissions, with 11.6 metric tons, corresponding to 10 percent of the total emissions.

The total amount of GHG emissions from Alternative G-4 is 42.1 metric tons of CO_2e. The main contributor the GHG emissions is the laboratory analytical services; the amount of emissions resulting from this activity is 35 metric tons of CO_2e, corresponding to 83 percent of the total GHG emissions. The transportation of personnel is the activity with the second highest contribution to GHG emissions, 6.4 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 15.1 percent of the total GHG emissions. Production of PVC is the activity with the third highest contribution to the CO_2e emissions, with 0.3 metric tons, corresponding to 0.7 percent of the total emissions.

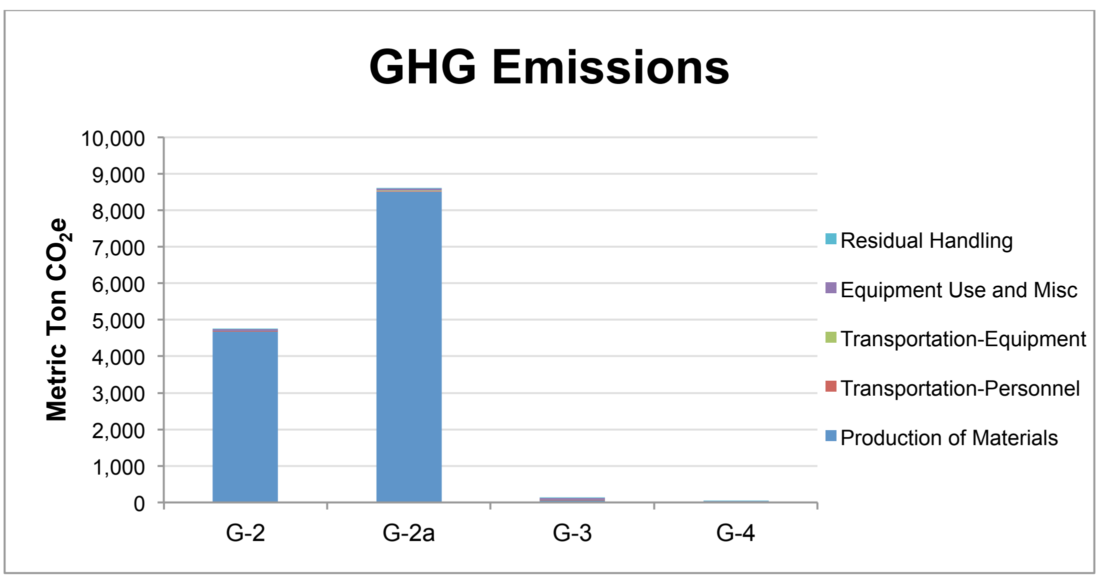


Figure E1: GHG Emissions for Proposed Alternatives at Building 82, NAS South Weymouth

Figure E2 shows the breakdown of the percent that each of main activities of each alternative (x-axis) contributes to the GHG emissions (y-axis).

The total amount of GHG emissions for Alternative G-2 is 4,735 metric tons of CO_2e. The production of materials is the activity sector with the highest contribution to the emissions, with 4,676.5 metric tons of CO_2e, corresponding to 98.8 percent of the total emissions. The equipment use and miscellaneous sector contributes with 39.8 metric tons of CO_2e, corresponding to 0.8 percent of the total emissions. Transportation of personnel accounts for 0.2 percent of the total emissions, approximately 10.7 metric tons of CO_2e.

The total amount of GHG emissions for Alternative G-2a is 8,590 metric tons of CO_2e. The production of materials is the activity sector with the highest contribution to the emissions, with 8,511 metric tons of CO_2e, corresponding to 99.1 percent of the total emissions. The equipment use and miscellaneous sector contributes with 52.1 metric tons of CO_2e, corresponding to 0.6 percent of the total emissions. Transportation of equipment and materials accounts for 0.2 percent of the total emissions, approximately 14.53 metric tons of CO_2e.

The total amount of GHG emissions for Alternative G-3 is 115 metric tons of CO_2e. The production of materials is the activity sector with the highest contribution to the emissions, with 60.2 metric tons of CO_2e, corresponding to 52.4 percent of the total emissions. The equipment use and miscellaneous sector contributes with 40.4 metric tons of CO_2e, corresponding to 35.1 percent of the total emissions. Transportation of personnel accounts for 10 percent of the total emissions, approximately 11.6 metric tons of CO_2e.

The total amount of GHG emissions for Alternative G-4 is 42.1 metric tons of CO_2e. The equipment use and miscellaneous is the activity sector with the highest contribution to the emissions, with 35 metric tons of CO_2e, corresponding to 83 percent of the total emissions. Transportation of personnel contributes with 6.4 metric tons of CO_2e, corresponding to 15.2 percent of the total emissions. Manufacture of raw materials accounts for 0.7 percent of the total emissions, approximately 0.3 metric tons of CO_2e.

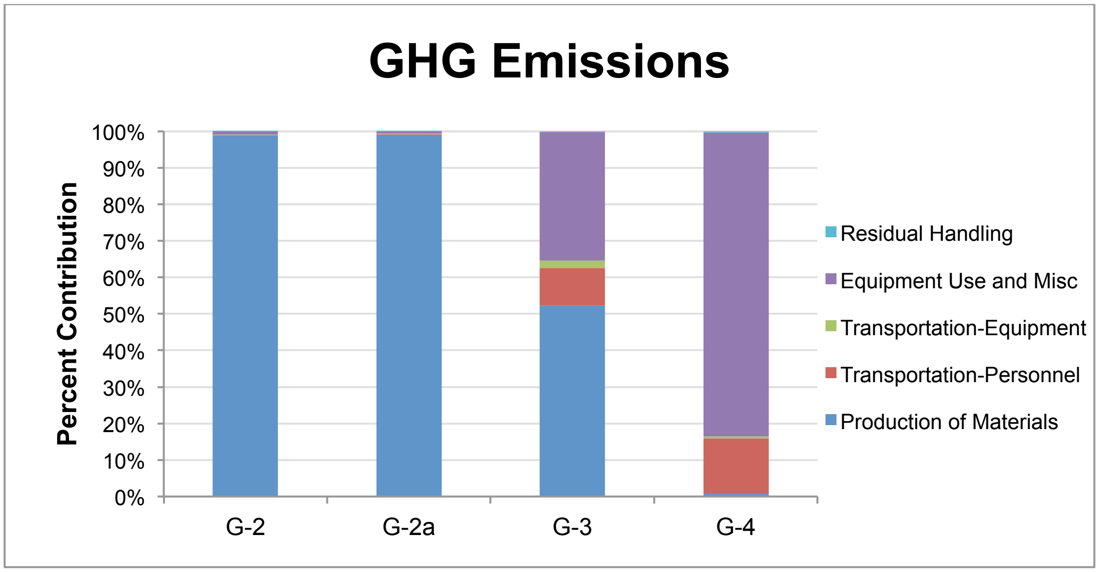


Figure E2: GHG Emissions percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

Criteria Pollutant Emissions

NO_X

Figure E3 shows the breakdown of the NO_X emissions for the two alternatives evaluated. The x–axis of this figure represents Alternative G-2, Alternative G-2a, Alternative G-3 and Alternative G-4, the y-axis represents the NO_X emissions in metric tons.

The total amount of NO_X emissions from Alternative G-2 is $1.6x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $1.3x10^{-1}$ metric tons of NO_X, corresponding to approximately 79 percent of the total NO_X emissions. The use of the DPT drill rig emits $2.6x10^{-2}$ metric tons of NO_X, corresponding to approximately 16 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of personnel, emitting $3.9x10^{-3}$ metric tons of NO_X corresponding to 2.5 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-2a is $2.1x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $1.6x10^{-1}$ metric tons of NO_X, corresponding to approximately 74 percent of the total NO_X emissions. The use of the DPT drill rig emits $4.5x10^{-2}$ metric tons of NO_X, corresponding to approximately 20.8 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of personnel, emitting $4.5x10^{-3}$ metric tons of NO_X corresponding to 2.1 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-3 is $1.5x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $1.3x10^{-1}$ metric tons of NO_X, corresponding to approximately 83 percent of the total NO_X emissions. The use of the DPT drill rig emits $1.9x10^{-2}$ metric tons of NO_X, corresponding to approximately 12.3 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of personnel, emitting $4.3x10^{-3}$ metric tons of NO_X corresponding to 2.8 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-4 is $1.2x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $1.2x10^{-1}$ metric tons of NO_X, corresponding to approximately 97 percent of the total NO_X emissions. The transportation of personnel emits $2.36x10^{-3}$ metric tons of NO_X, corresponding to approximately 1.9 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the use of the DPT drill rig, emitting $1.3x10^{-3}$ metric tons of NO_X corresponding to 1 percent of the total NO_X emissions.

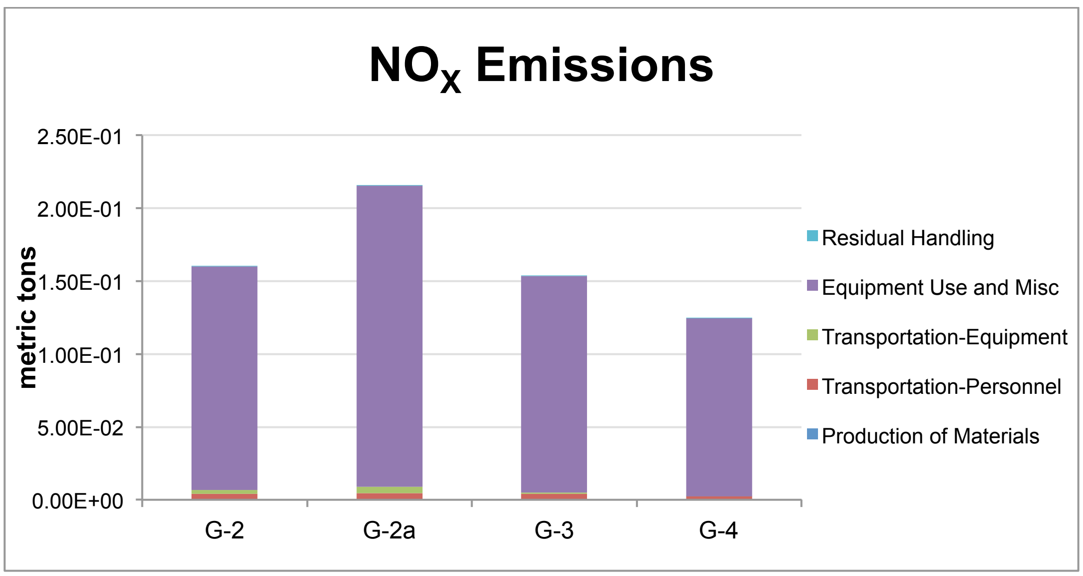


Figure E3 NO_X Emissions for Proposed Alternatives at SRA, Building 82, NAS South Weymouth

Figure E4 shows the percentage contribution from each of the main activity sectors.

For Alternative G-2, the total amount of NO_X is $1.6x10^{-1}$ metric tons. The equipment use and miscellaneous sector is the activity that contributes the most, $1.5x10^{-2}$ metric tons of NO_X, approximately 96 percent of the total NO_X emissions. Transportation of personnel is the activity with the second highest contribution to the NO_X emissions, emitting $3.9x10^{-3}$ metric tons, approximately 2.5 percent of the total

NO_X emissions. Transportation of equipment and materials contributes with 2.6x10^{-3} metric tons of NO_X, approximately 1.6 percent of the total NO_X emissions.

For Alternative G-2a, the total amount of NO_X is 2.1x10^{-1} metric tons. The equipment use and miscellaneous sector is the activity that contributes the most, 2.06x10^{-1} metric tons of NO_X, approximately 96 percent of the total NO_X emissions. Transportation of equipment and materials is the activity with the second highest contribution to the NO_X emissions, emitting 4.6x10^{-3} metric tons, approximately 2.1 percent of the total NO_X emissions. Transportation of personnel contributes with 4.5x10^{-3} metric tons of NO_X, approximately 2.1 percent of the total NO_X emissions.

For Alternative G-3, the total amount of NO_X is 1.5x10^{-1} metric tons. The equipment use and miscellaneous sector is the activity that contributes the most, 1.5x10^{-1} metric tons of NO_X, approximately 96 percent of the total NO_X emissions. Transportation of personnel is the activity with the second highest contribution to the NO_X emissions, emitting 4.3x10^{-3} metric tons, approximately 2.8 percent of the total NO_X emissions. Transportation of equipment and materials contributes with 7.9x10^{-4} metric tons of NO_X, approximately 0.5 percent of the total NO_X emissions.

For Alternative G-4, the total amount of NO_X is 1.2x10^{-1} metric tons. The equipment use and miscellaneous sector is the activity that contributes the most, 1.2x10^{-1} metric tons of NO_X, approximately 98 percent of the total NO_X emissions. Transportation of personnel is the activity with the second highest contribution to the NO_X emissions, emitting 2.36x10^{-3} metric tons, approximately 1.9 percent of the total NO_X emissions. Transportation of equipment and materials contributes with 7.6x10^{-5} metric tons of NO_X, approximately 0.1 percent of the total NO_X emissions.

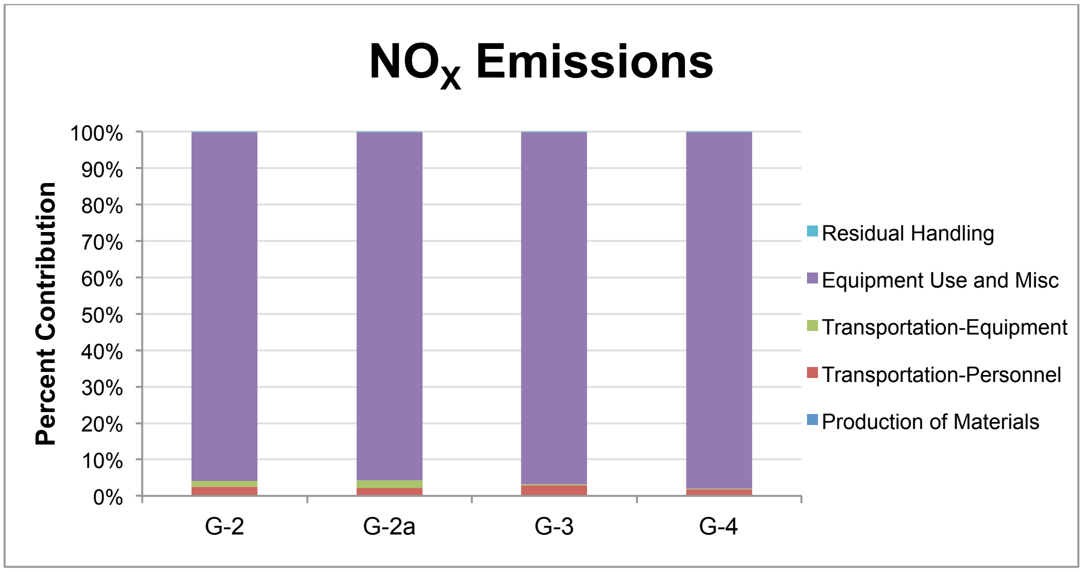


Figure E4: NO_X Emissions percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

SO_X

Figure E5 contains the distribution of the SO_X emissions resulting from the activities related to Alternatives G-2, G-2a, G-3 and G-4. The x-axis of this graph represents the alternatives evaluated; the y-axis represents the SO_X emissions in metric tons.

The total amount of SO_X emissions from Alternative G-2 is 7.7 metric tons. The activity with the highest contribution to SO_X emissions is the production of hydrogen peroxide used as the Fenton's Reagent, emitting 7.6 metric tons of SO_X, corresponding to approximately 98.6 percent of the total SO_X emissions. Laboratory analytical services emits 8.5×10^{-2} metric tons of SO_X, corresponding to approximately 1.1 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of PVC, emitting 1.61×10^{-2} metric tons of SO_X corresponding to 0.21 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-2a is 14.01 metric tons. The activity with the highest contribution to SO_X emissions is the production of hydrogen peroxide used as the Fenton's Reagent, emitting 13.9 metric tons of SO_X, corresponding to approximately 99 percent of the total SO_X emissions. Laboratory analytical services emits 1.06×10^{-1} metric tons of SO_X, corresponding to approximately 0.76 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of PVC, emitting 2.8×10^{-2} metric tons of SO_X corresponding to 0.2 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-3 is $1.5x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting $8.5x10^{-2}$ metric tons of SO_X, corresponding to approximately 54.5 percent of the total SO_X emissions. Manufacture of vegetable oil used during the treatment as EOS emits $5.2x10^{-2}$ metric tons of SO_X, corresponding to approximately 33.2 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of HDPE used for the liners for the equipment pads, emitting $3.5x10^{-3}$ metric tons of SO_X corresponding to 2.2 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-4 is $8.1x10^{-2}$ metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting $8.01x10^{-2}$ metric tons of SO_X, corresponding to approximately 99.1 percent of the total SO_X emissions. Manufacture of PVC used for the construction of the monitoring wells emits $5.8x10^{-4}$ metric tons of SO_X, corresponding to approximately 0.7 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the transportation of personnel, emitting $8.3x10^{-5}$ metric tons of SOX corresponding to 0.1 percent of the total SO_X emissions.

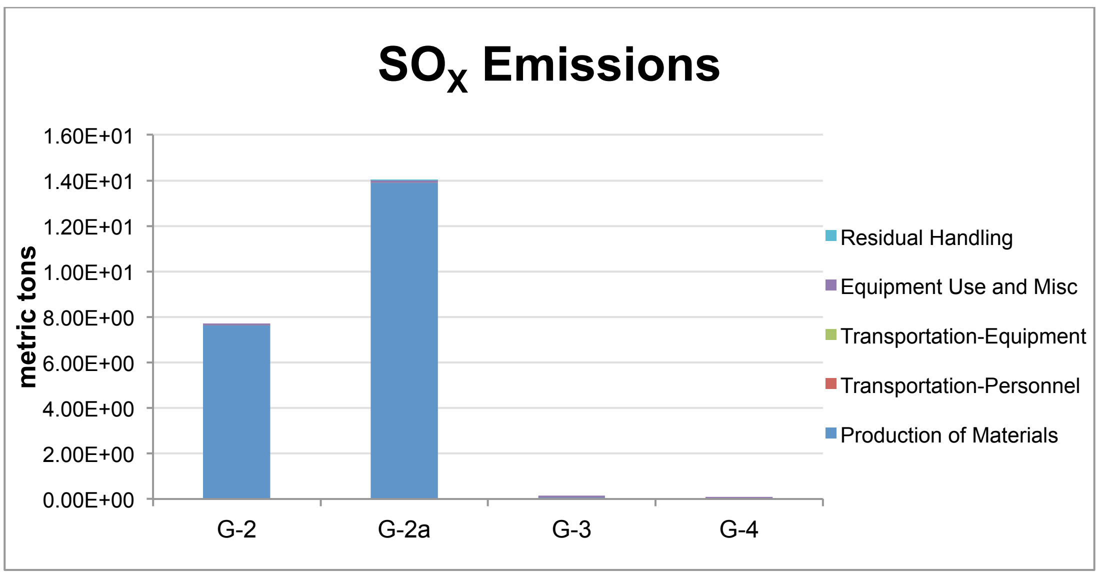


Figure E5: SO_X Emissions for Proposed Alternatives at Building 82, NAS South Weymouth

Figure E6 shows the percentage breakdown of the activities contributing to SO_X emissions.

For Alternative G-2, the total amount of SO_X is 7.7 metric tons. The equipment manufacture of materials sector is the activity that contributes the most to these emissions, 7.64 metric tons of SO_X, approximately 99 percent of the total SO_X emissions. Equipment use and miscellaneous is the activity with the second highest contribution to the SO_X emissions, emitting $8.6x10^{-2}$ metric tons, approximately 1.1 percent of the total SO_X emissions. Transportation of personnel contributes with $1.4x10^{-4}$ metric tons of SO_X, approximately less than one percent of the total SO_X emissions.

For Alternative G-2a, the total amount of SO_X is 14.01 metric tons. The equipment manufacture of materials sector is the activity that contributes the most to these emissions, 13.9 metric tons of SO_X, approximately 99.2 percent of the total SO_X emissions. Equipment use and miscellaneous is the activity with the second highest contribution to the SO_X emissions, emitting $1.1x10^{-1}$ metric tons, approximately 0.8 percent of the total SO_X emissions. Transportation of personnel contributes with $1.6x10^{-4}$ metric tons of SO_X, approximately less than 0.1 percent of the total SO_X emissions.

For Alternative G-3, the total amount of SO_X is $1.5x10^{-1}$ metric tons. The equipment use and miscellaneous sector is the activity that contributes the most to these emissions, $8.9x10^{-2}$ metric tons of SO_X, approximately 56.7 percent of the total SO_X emissions. Manufacture of the raw materials is the activity with the second highest contribution to the SO_X emissions, emitting $6.7x10^{-2}$ metric tons, approximately 43.2 percent of the total SO_X emissions. Transportation of personnel contributes with 1.5x10-4 metric tons of SO_X, approximately 0.1 percent of the total SO_X emissions.

For Alternative G-4, the total amount of SO_X is $8.1x10^{-2}$ metric tons. The equipment use and miscellaneous sector is the activity that contributes the most to these emissions, $8.06x10^{-2}$ metric tons of SO_X, approximately 99.2 percent of the total SO_X emissions. Manufacture of the raw materials is the activity with the second highest contribution to the SO_X emissions, emitting $5.8x10^{-4}$ metric tons, approximately 0.7 percent of the total SO_X emissions. Transportation of personnel contributes with $8.3x10^{-5}$ metric tons of SO_X, approximately 0.1 percent of the total SO_X emissions.

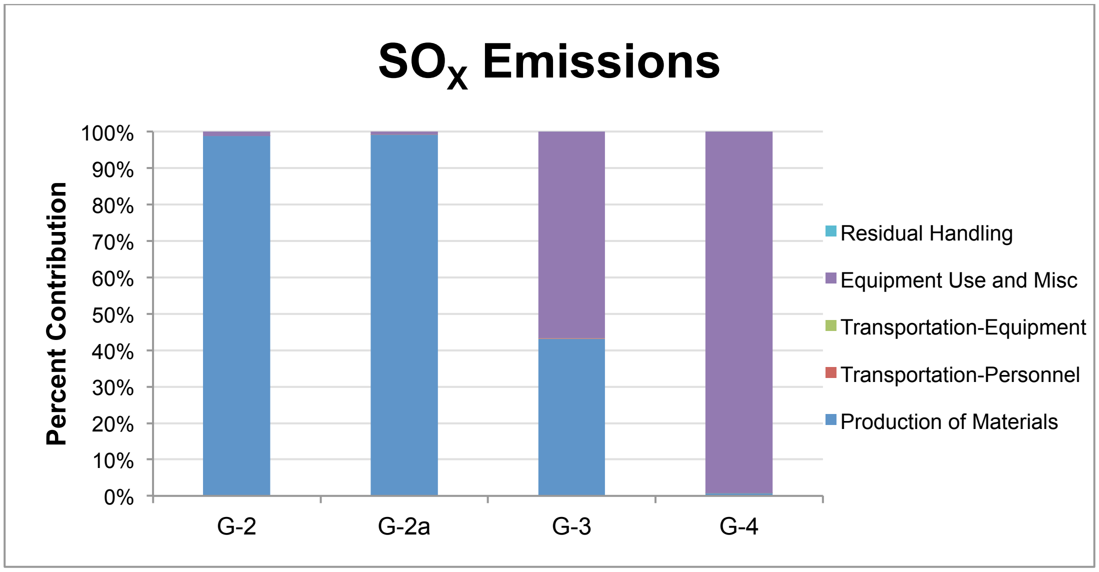


Figure E6: SO_X Emissions percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

PM_{10}

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in Alternatives G-2, G-2a, G-3 and G-4 are shown in Figure E7. The x-axis of this figure represents the two alternatives evaluated, while the y-axis represents the PM_{10} emissions in metric tons.

The total PM10 emissions resulting from Alternative G-2 is 2.9 metric tons. The activity with the highest contribution to these emissions is the production of hydrogen peroxide, emitting 2.8 metric ton of PM_{10}, approximately 99.6 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the laboratory analytical services; this activity contributes with 0.11 percent of the total PM_{10} emissions, approximately $3.2x10^{-3}$ metric tons of PM_{10}. The use of the DPT drill rig is the activity with the third highest contribution, approximately 0.09 percent of the total PM_{10} emissions ($2.6x10^{-3}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-2a is 5.3 metric tons. The activity with the highest contribution to these emissions is the production of hydrogen peroxide, emitting 5.2 metric ton of PM_{10}, approximately 99.6 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the DPT drilling rig; this activity contributes with 0.08 percent of the total PM_{10} emissions, approximately $4.5x10^{-3}$ metric tons of PM_{10}. Laboratory analytical services is the activity with the third highest contribution, approximately 0.08 percent of the total PM_{10} emissions ($4.04x10^{-3}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-3 is $9.6x10^{-3}$ metric tons. The activity with the highest contribution to these emissions is the laboratory analytical services, emitting 3.2x10-3 metric ton of PM_{10}, approximately 34 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the DPT drilling rig; this activity contributes with 19.7 percent of the total PM_{10} emissions, approximately $1.9x10^{-3}$ metric tons of PM_{10}. The production of PVC the activity with the third highest contribution, approximately 18.2 percent of the total PM_{10} emissions ($1.7x10^{-3}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-4 is $4x10^{-3}$ metric tons. The activity with the highest contribution to these emissions is the laboratory analytical services, emitting $3.06x10^{-3}$ metric ton of PM_{10}, approximately 80 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the transportation of personnel; this activity contributes with 12.4 percent of the total PM_{10} emissions, approximately $4.8x10^{-4}$ metric tons of PM_{10}. The use of the DPT drill rig is the activity with the third highest contribution, approximately 3.3 percent of the total PM_{10} emissions ($1.3x10^{-4}$ metric tons of PM_{10}).

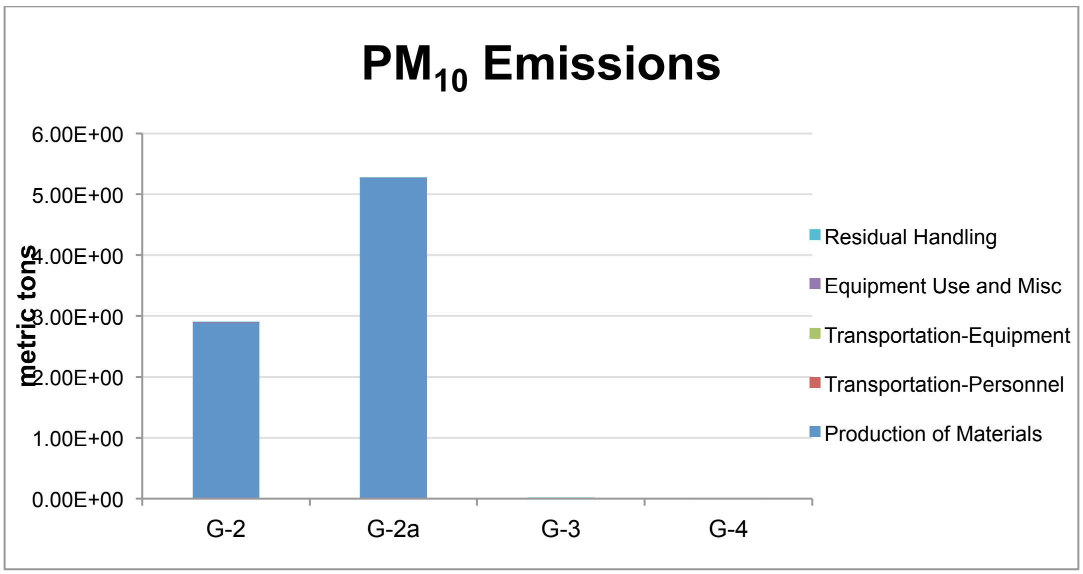


Figure E7: PM_{10} Emissions for Proposed Alternatives at Building 82, NAS South Weymouth

Figure E8 shows the percentage of PM_{10} emissions contributed by each of the activity sectors per alternative.

The total PM_{10} emissions resulting from Alternative G-2 is 2.9 metric tons. The production of materials to be used during this alternative is the activity with the highest contribution to PM_{10}, emitting 2.9 metric ton of PM_{10}, approximately 99.7 percent of the total PM_{10} emissions. The sector with the second highest

PM_{10} release is the equipment use and miscellaneous; this sector contributes with 0.3 percent of the total PM_{10} emissions, approximately $7.41x10^{-3}$ metric tons of PM_{10}. The transportation of personnel is the activity group with the third highest contribution, less than half of one percent of the total PM_{10} emissions (approximately $8x10^{-4}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-2a is 5.3 metric tons. The production of materials to be used during this alternative is the activity with the highest contribution to PM_{10}, emitting 5.2 metric ton of PM_{10}, approximately 99.8 percent of the total PM_{10} emissions. The sector with the second highest PM_{10} release is the equipment use and miscellaneous; this sector contributes with 0.2 percent of the total PM_{10} emissions, approximately $1.13x10^{-2}$ metric tons of PM_{10}. The transportation of personnel is the activity group with the third highest contribution, less than 0.01 percent of the total PM_{10} emissions (approximately $9.1x10^{-4}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-3 is $9.6x10^{-3}$ metric tons. The equipment use and miscellaneous sector during this alternative has the highest contribution to PM_{10}, emitting $6.3x10^{-3}$ metric ton of PM_{10}, approximately 66 percent of the total PM_{10} emissions. The sector with the second highest PM_{10} release is the production of materials; this sector contributes with 24 percent of the total PM_{10} emissions, approximately $2.3x10^{-3}$ metric tons of PM_{10}. The transportation of personnel is the activity group with the third highest contribution, approximately 9 percent of the total PM_{10} emissions (approximately $8.7x10^{-4}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative G-4 is $4x10^{-3}$ metric tons. The equipment use and miscellaneous sector during this alternative has the highest contribution to PM_{10}, emitting $3.3x10^{-3}$ metric ton of PM_{10}, approximately 85 percent of the total PM_{10} emissions. The sector with the second highest PM_{10} release is the transportation of personnel; this sector contributes with 12.5 percent of the total PM_{10} emissions, approximately $4.8x10^{-4}$ metric tons of PM_{10}. The transportation of personnel is the activity group with the third highest contribution, approximately 9 percent of the total PM_{10} emissions (approximately $8.7x10^{-4}$ metric tons of PM_{10}).

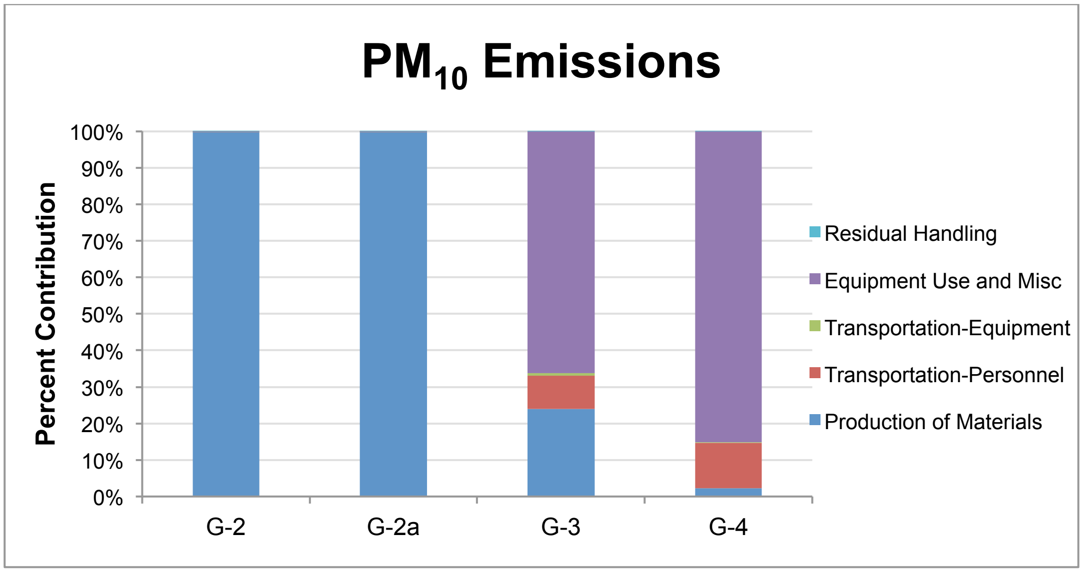


Figure E8: PM_{10} Emissions percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

Energy Consumption

The energy consumption for each of the alternatives evaluated is shown in Figure E9. The x-axis shows the four alternatives evaluated, and the y-axis shows the amount of energy consumed in units of million British Thermal Units (MMBTU).

The total amount of energy consumed by Alternative G-2 is 123,794 MMBTU. The activity with the highest energy consumption is the production of hydrogen peroxide, utilizing 122,379 MMBTU, corresponding to approximately 98.8 percent of the total energy consumption. The activity with the second highest energy use is the laboratory analytical services, consuming 547 MMBTU, approximately 0.44 percent of the total energy consumption of this alternative. The third highest energy consumptions corresponds to the production of PVC, where 514 MMBTUs are consumed, approximately 0.42 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-2a is 224,879 MMBTU. The activity with the highest energy consumption is the production of hydrogen peroxide, utilizing 222,772 MMBTU, corresponding to approximately 99 percent of the total energy consumption. The activity with the second highest energy use is the production of PVC, consuming 898 MMBTU, approximately 0.4 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the laboratory analytical services, where 688 MMBTUs are consumed, approximately 0.31 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-3 is 7,454 MMBTU. The activity with the highest energy consumption is the production of vegetable oil, utilizing 6,220 MMBTU, corresponding to approximately 83.4 percent of the total energy consumption. The activity with the second highest energy use is laboratory analytical services, consuming 552 MMBTU, approximately 7.4 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the production of PVC, where 387 MMBTUs are consumed, approximately 5.2 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-4 is 628.3 MMBTU. The activity with the highest energy consumption is the laboratory analytical services, utilizing 521 MMBTU, corresponding to approximately 83 percent of the total energy consumption. The activity with the second highest energy use is transportation of personnel, consuming 80.3 MMBTU, approximately 12.8 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the production of PVC, where 18.7 MMBTUs are consumed, approximately 3 percent of the total energy used during this alternative.

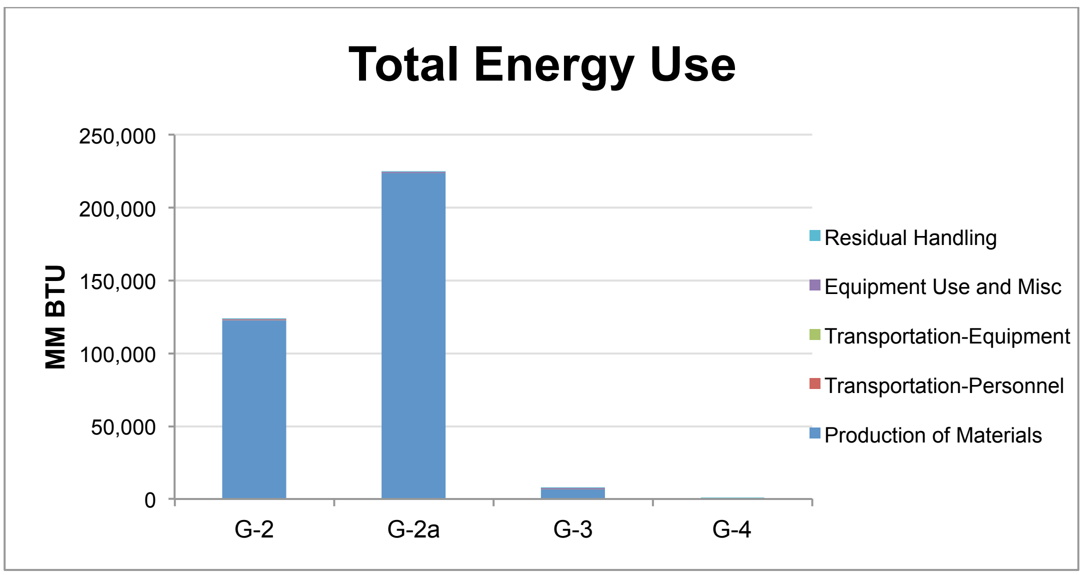


Figure E9: Energy Consumption for Proposed Alternatives at Building 82, NAS South Weymouth

Figure E10 shows the percentage breakdown contribution of energy consumption from the different activity groups.

The total amount of energy consumed by Alternative G-2 is 123,794 MMBTU. The sector with the highest energy consumption is the manufacturing of raw materials, utilizing 122,925 MMBTU, corresponding to approximately 99.3 percent of the total energy consumption. The activity sector with the second highest energy use is the equipment use and miscellaneous, consuming 623 MMBTU, approximately 0.5 percent of the total energy consumption of this alternative. The sector with the third highest energy consumption corresponds to the transportation of personnel, where 134 MMBTUs are consumed, approximately 0.1 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-2a is 224,879 MMBTU. The sector with the highest energy consumption is the manufacturing of raw materials, utilizing 223,702 MMBTU, corresponding to approximately 99.5 percent of the total energy consumption. The activity sector with the second highest energy use is the equipment use and miscellaneous, consuming 830 MMBTU, approximately 0.4 percent of the total energy consumption of this alternative. The sector with the third highest energy consumption corresponds to the transportation of equipment and material, where 189 MMBTUs are consumed, approximately 0.1 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-3 is 7,454 MMBTU. The sector with the highest energy consumption is the manufacturing of raw materials, utilizing 6,640 MMBTU, corresponding to approximately 89 percent of the total energy consumption. The activity sector with the second highest energy use is the equipment use and miscellaneous, consuming 630 MMBTU, approximately 8.5 percent of the total energy consumption of this alternative. The sector with the third highest energy consumption corresponds to the transportation of personnel, where 145 MMBTUs are consumed, approximately 2 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-4 is 628.3 MMBTU. The sector with the highest energy consumption is the equipment use and miscellaneous, utilizing 32.04 MMBTU, corresponding to approximately 83.2 percent of the total energy consumption. The activity sector with the second highest energy use is the transportation of personnel, consuming 6.39 MMBTU, approximately 15.2 percent of the total energy consumption of this alternative. The sector with the third highest energy consumption corresponds to the manufacture of raw materials, where 0.3 MMBTUs are consumed, approximately 0.7 percent of the total energy used during this alternative.

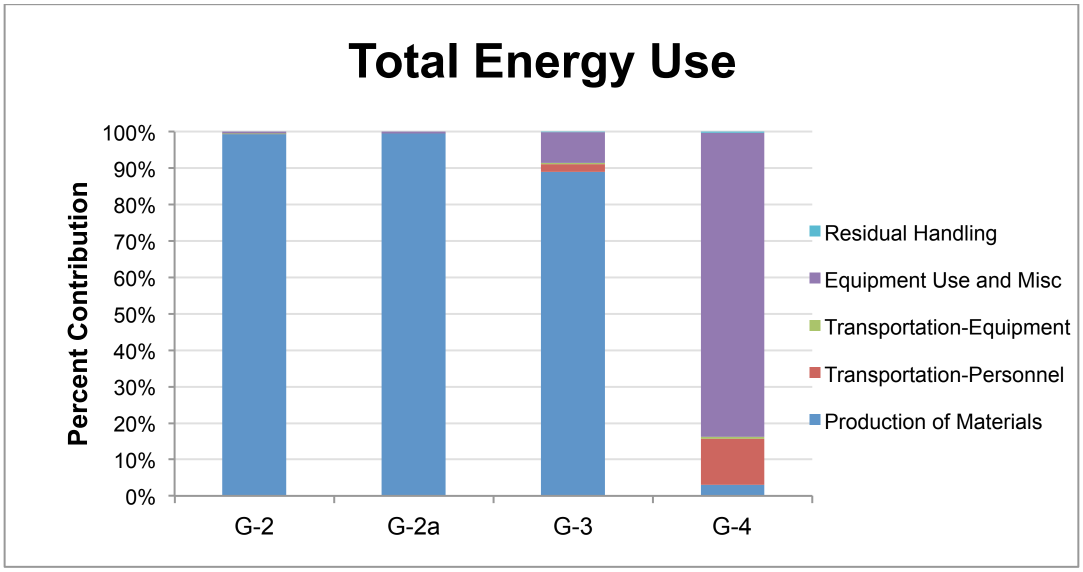


Figure E10: Energy Consumption percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

Water Usage

The water consumption of the evaluated alternatives is shown in Figure E11. The x-axis shows the four evaluated alternatives, and the y-axis show the amount of water consumed in thousands of gallons.

The total water consumption for Alternative G-2 is 177.06 thousand gallons of water. The amount of water used for injection purposes during the remedial alternative is 93.7 percent (166 thousand gallons of water) of the total amount of water consumed. The water used to produce PVC, corresponds to 4.7 percent of the total water used (approximately 8.3 thousand gallons of water). Decontamination water corresponds to 1.1 percent of the total water used during this Alternative; 2 thousand gallons of water were used for this purpose.

The total water consumption for Alternative G-2a is 322.093 thousand gallons of water. The amount of water used for injection purposes during the remedial alternative is 94 percent (303 thousand gallons of water) of the total amount of water consumed. The water used to produce PVC, corresponds to 4.5 percent of the total water used (approximately 14.4 thousand gallons of water). Decontamination water corresponds to 0.9 percent of the total water used during this Alternative; 3 thousand gallons of water were used for this purpose.

The total water consumption for Alternative G-3 is 253.3 thousand gallons of water. The amount of water used for the production of vegetable oil to use during the remedial alternative is 62.4 percent (158.1

thousand gallons of water) of the total amount of water consumed. Injection water corresponds to 33.6 percent of the total water used (approximately 85.2 thousand gallons of water). The production of PVC utilizes water corresponding to 2.4 percent; 6.2 thousand gallons of water were used for this purpose.

The total water consumption for Alternative G-4 is 0.3 thousand gallons of water, which corresponds to the amount of water used for the production of PVC that will be used during the construction of the monitoring wells.

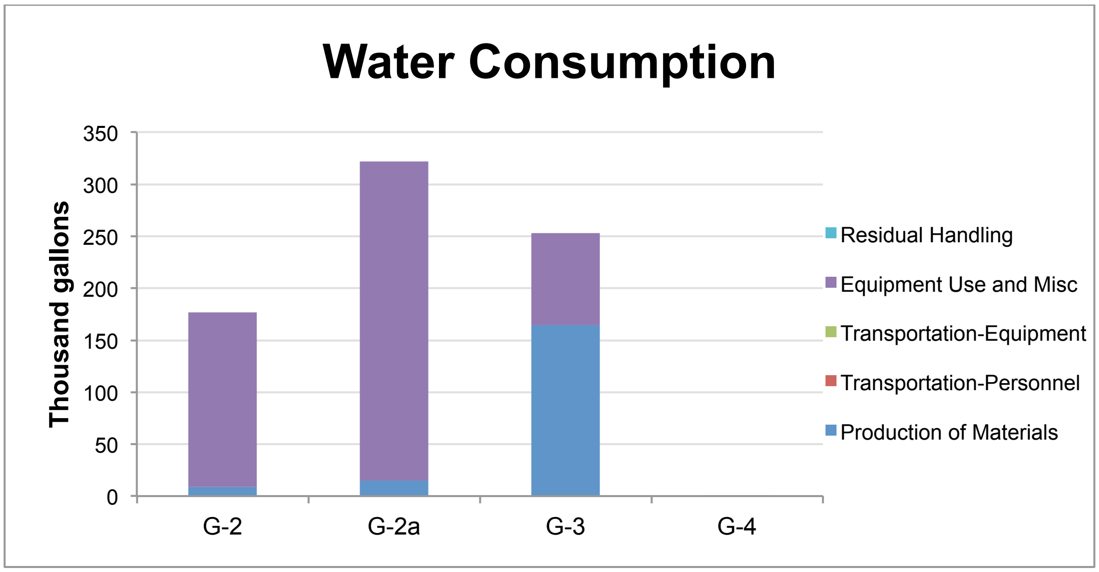


Figure E11: Water Consumption for Proposed Alternatives at Building 82, NAS South Weymouth

Figure E12 has a representation of the percentage breakdown of the contribution of the different sectors of the water use through the lifetime of the alternatives.

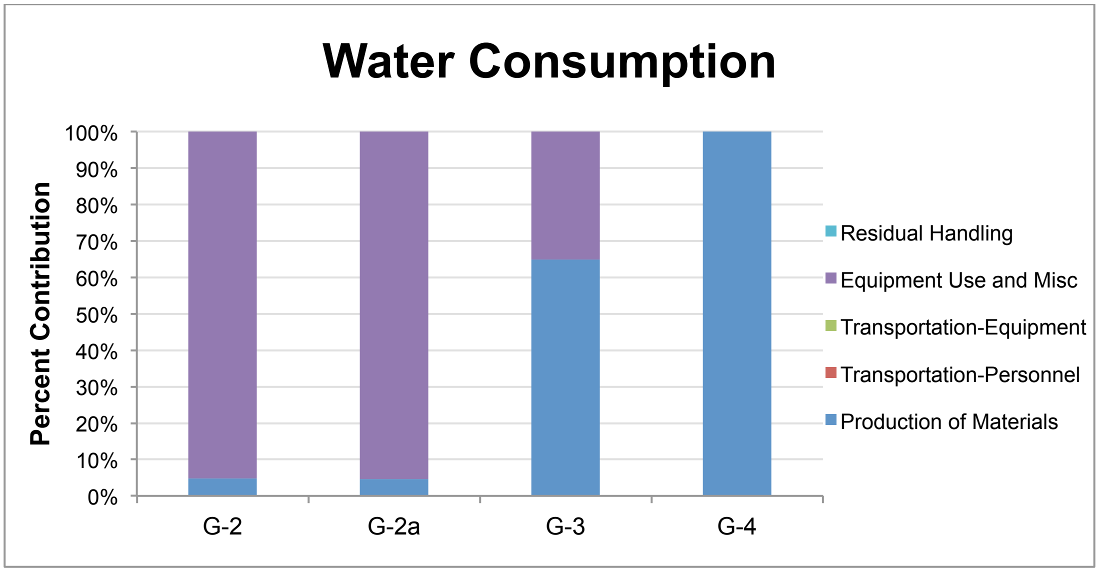


Figure E12: Water Consumption percentage breakdown for Proposed Alternatives at Building 82, NAS South Weymouth

Accident Risk

Accident Risk Fatality

Figure E13 shows the risk of fatality between the evaluated alternatives. The x-axis represents the two alternatives evaluated, and the y-axis represents the risk of fatality.

For all Alternatives, the activity with the highest risk of fatality is the transportation of personnel followed by the transportation of equipment and materials.

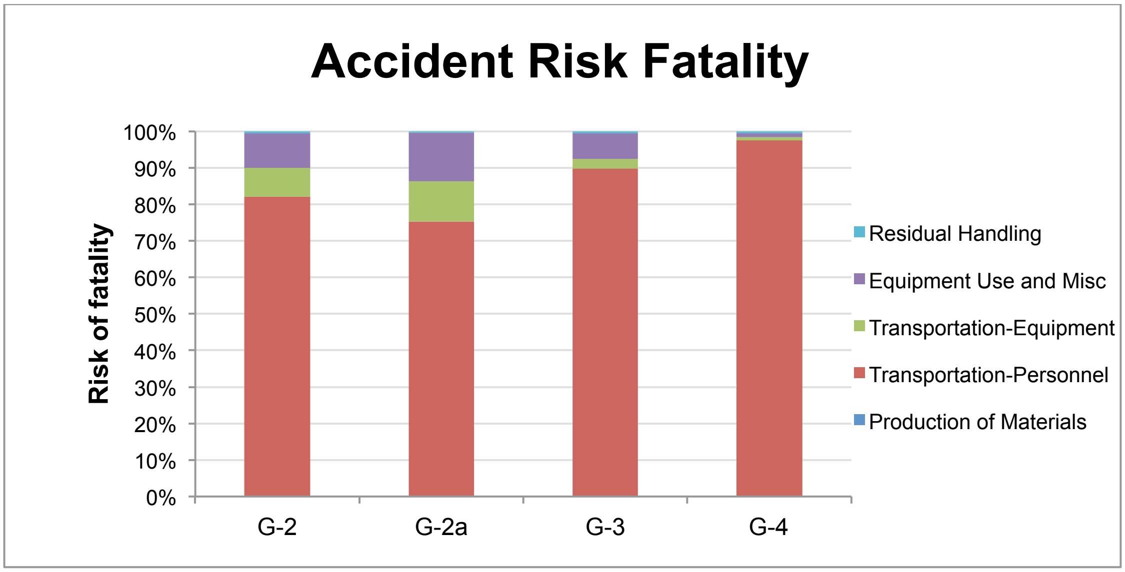


Figure E13 Risk of Fatality for Proposed Alternatives Building 82, NAS South Weymouth

Accident Risk Injury

Figure E14 shows the risk of injury between the evaluated alternatives. The x-axis represents the two alternatives evaluated, and the y-axis represents the risk of injury.

For all Alternatives, the activity with the highest risk of injury is the transportation of personnel; the activity with the second highest risk of injury is the equipment use.

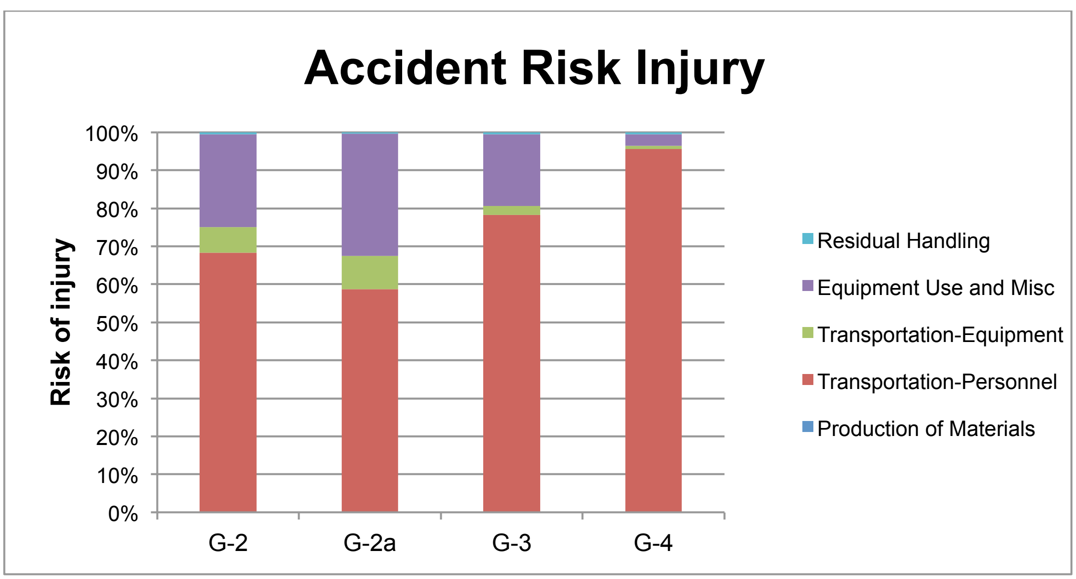


Figure E14 Risk of Injury for Proposed Alternatives Building 82, NAS South Weymouth

CONCLUSIONS AND RECOMMENDATIONS

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table E2 for details).

Figures E2, E4, E6, E8, E10 and E12 show the percentage breakdown of each of the sectors that take place during the remedial alternatives. In these graphs, it is easy to identify the sector whose contribution is largest from all other sectors to that impact category. An advantage to identifying where the large contributions are, the optimization process for lowering the environmental impacts is faster and might be could be more efficient.

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- Alternatives G-2 and G-2a: Consider revision of the amount of Fenton Reagent used during the treatment; this would reduce significantly the amount of GHG emissions released to the atmosphere as well as the amount of energy utilized.
- All Alternatives: Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.
- Alternatives G-2, G-2a and G-3: Consider optimizing of the use of equipment, particularly the use of the DPT drill rig, and even the type of equipment used during operations.
- Alternatives G-3: Consider the optimization of the use of EOS during the treatment stage. The environmental impact of this chemical has an influence in most of the impact categories evaluated.
- Alternative G-4: Design an optimized sampling schedule that minimizes the number of samples that need to be analyzed and maximizes the results, for this alternative laboratory analytical services are the main driver for most of the impact categories evaluated.
- All Alternatives: Optimize the number of samples analyzed during the LTM stage given that the laboratory analytical services is one of the major drivers in some of the impact categories.

- All Alternatives: Consider ways to reduce vehicle mileage to reduce worker risk as well as energy use and emissions. Encourage site workers to carpool daily to the site to reduce total vehicle mileage.

Laboratory analytical services is an activity that takes place every year during the lifetime of each of the alternatives. In the case for all of the alternatives, each year there is a large number of samples that need analytical analysis; therefore, this activity has a higher burden over the impact categories. The environmental footprint of the LTM, where the laboratory analytical services take place, is higher than the use of the construction equipment due to the relative low number of operation hours compared to the amount of working hours for the analytical services.

<u>REFERENCES</u>

(a) NAVFAC, DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010

(b) NAVFAC, DON Policy on SiteWise™ Optimization/GSR Tool Usage, email received from Brian Harrison/NAVFAC HQ dated 10 AUG 2010

Table E-1
Environmental Evaluation Results
Building 82, NAS South Weymouth
Weymouth, Massachusetts

Alternative	Activities	GHG Emissions	Total Energy Used	Water Impacts	NOx Emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
G-2	Materials Production	4,676.47	122,925.62	8,550.94	0.00E+00	7.64E+00	2.89E+00	NA	NA
	Transportation-Personnel	10.67	134.27	NA	3.95E-03	1.39E-04	8.01E-04	2.18E-04	1.76E-02
	Transportation-Equipment	8.17	106.69	NA	2.57E-03	4.54E-05	2.28E-04	2.11E-05	1.70E-03
	Equipment Use and Misc	39.85	623.73	168,511.13	1.54E-01	8.63E-02	7.41E-03	2.51E-05	6.30E-03
	Residual Handling	0.31	4.04	NA	9.72E-05	1.72E-06	8.64E-06	1.56E-06	1.26E-04
	Total	4,735.48	123,794.34	177,062.07	0.160	7.726	2.898	0.000	0.026
G-2a	Materials Production	8,510.87	223,702.10	14,706.40	0.00E+00	1.39E+01	5.26E+00	NA	NA
	Transportation-Personnel	12.12	152.49	NA	4.49E-03	1.58E-04	9.10E-04	2.48E-04	2.00E-02
	Transportation-Equipment	14.53	189.67	NA	4.57E-03	8.08E-05	4.06E-04	3.68E-05	2.96E-03
	Equipment Use and Misc	52.08	830.70	307,387.36	2.06E-01	1.10E-01	1.13E-02	4.35E-05	1.09E-02
	Residual Handling	0.32	4.18	NA	1.01E-04	1.78E-06	8.95E-06	1.56E-06	1.26E-04
	Total	8,589.92	224,879.14	322,093.76	0.215	14.013	5.272	0.000	0.034
G-3	Materials Production	60.22	6,640.78	164,625.47	5.48E-09	6.77E-02	2.30E-03	NA	NA
	Transportation-Personnel	11.59	145.77	NA	4.29E-03	1.51E-04	8.70E-04	2.37E-04	1.91E-02
	Transportation-Equipment	2.53	32.99	NA	7.94E-04	1.41E-05	7.06E-05	7.11E-06	5.73E-04
	Equipment Use and Misc	40.38	630.75	88,665.32	1.49E-01	8.89E-02	6.33E-03	1.84E-05	4.62E-03
	Residual Handling	0.31	4.00	NA	9.63E-05	1.70E-06	8.57E-06	1.56E-06	1.26E-04
	Total	115.02	7,454.29	253,290.79	0.154	0.157	0.01	0.000	0.024
G-4	Materials Production	0.30	18.76	300.90	0.00E+00	5.85E-04	8.44E-05	NA	NA
	Transportation-Personnel	6.39	80.34	NA	2.36E-03	8.32E-05	4.79E-04	1.31E-04	1.05E-02
	Transportation-Equipment	0.24	3.16	NA	7.61E-05	1.35E-06	6.76E-06	1.17E-06	9.42E-05
	Equipment Use and Misc	35.04	524.26	0.00	1.22E-01	8.06E-02	3.27E-03	1.28E-06	3.22E-04
	Residual Handling	0.14	1.84	NA	4.43E-05	7.83E-07	3.94E-06	7.80E-07	6.28E-05
	Total	42.11	628.36	300.90	0.125	0.081	0.004	0.000	0.011

Table E-2
Environmental Impact Drivers
Building 82, NAS South Weymouth
Weymouth, Massachusetts

Alternative	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
G-2	Moderate	Moderate	Moderate	Moderate to high	Moderate	Moderate	High	Moderate to high
	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Injection water	Laboratory analytical services	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Transportation of personnel	Transportation of personnel
G-2a	High	High	High	High	High	High	High	High
	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Injection water	Laboratory analytical services	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Production of hydrogen peroxide (used as Fenton's Reagent during treatment)	Transportation of personnel	Transportation of personnel
G-3	Low	Low	Moderate to high	Moderate to high	Low	Low	Moderate to high	Moderate to high
	Production of vegetable oil used during treatment	Production of vegetable oil used during treatment	Production of vegetable oil used during treatment	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel
G-4	Low	Low	Low	Moderate	Low	Low	Moderate	Low to moderate
	Laboratory analytical services	Laboratory analytical services	Production of PVC to be used for constructing the monitoring wells	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel

APPENDIX E-2 INPUT INVENTORIES

Alternative G-2: In-Situ Chemical Oxidation, MNA, LUCs

RAC

Materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Decontamination water	2,000.00	gallons	
Injection Well Instalation	302.40	lb	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	125.00	lb	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation	2,721.60	lb	3780 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	500.00	lb	Assume PVC, 25 lb per unit, Assume 20 units

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent transportation	3,000	miles	60 days, 50 miles per day, 1 person
Site Health and Safety/QC	1,000	miles	20 days, 50 miles per day, 1 person
Site Support Labor	2,000	miles	20 days, 50 miles per day, 2 people
Bench Test labor	250	miles	5 days, 50 miles per day, 1 person
Pilot Study: injection labor	200	miles	2 days, 50 miles per day, 2 people
Pilot Study: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Full Treatment: injection labor	2,000	miles	10 days, 50 miles per day, 4 people
Full treatment: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Baseline sampling	2,000	miles	10 days, 50 miles per day, 4 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	20.00	ton	2 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.90	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 lb per 500 gal capacity tank
Clean Water Storage Tank	0.60	ton	4000 gallons capacity HPDE, 100 miles round trip
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.01	ton	22 lb per auger,
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.01	ton	22 lb per auger,

Transportation-materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection Well Instalation	0.15	ton	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.06	ton	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation	1.36	ton	3780 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.25	ton	Assume PVC, 25 lb per unit, Assume 20 units

Equipment Use

Item	Quantity	Units	Comments
DPT Drill Rig	15.36	hours	5 wells per day, 12 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	12	hours	1 hour per weel, 12 wells
DPT Drill Rig	138.24	hours	5 wells per day, 108 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	108	hours	1 hour per well, 108 wells

Residual Handling

Item	Quantity	Units	Comments
Decontamination water	8.32	ton	2,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	0.46	ton	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	4.17	ton	216 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Transportation-residual handling

Item	Quantity	Units	Comments
Decontamination water	100	miles	2,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	100.00	miles	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	100.00	miles	216 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Laboratory Analytical Services

Item	Quantity	Units	Comments
Bench Test Analysis	$1,000.00	dollars	5 samples, $200 per sample
Pilot Study Sampling	$1,000.00	dollars	5 samples, $200 per sample
Full Treatment Sampling	$1,000.00	dollars	5 samples, $200 per sample
Baseline Sampling	$3,200.00	dollars	2 events, 8 samples per event, $200 per sample

RAO

Materials

Item	Quantity	Units	Comments
ISCO Reagent	254,100.00	lb	Asssume hydrogen peroxide, 21,000 gallons, density 12.100 ppg
ISCO Injection Water	17,000.00	gallons	
ISCO Reagent	2,291,740.00	lb	Asssume hydrogen peroxide, 189,400 gallons, density 12.100 ppg
ISCO Makeup Water	149,000.00	gallons	

Transportation-equipment

Item	Quantity	Units	Comments
Pumps, pilot study	0.10	ton	5 pumps, 30 lb per pump, 100 miles round trip
Pumps, full treatment	0.39	ton	20 pumps, 30 lb per pump, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
ISCO Reagent	127.06	ton	Asssume hydrogen peroxide, 21,000 gallons, demsity 1.45 g/cm3
ISCO Injection Water	70.72	ton	
ISCO Reagent	1,145.95	ton	Asssume hydrogen peroxide, 189,400 gallons
ISCO Makeup Water	619.84	ton	

Equipment Use

Item	Quantity	Units	Comments
Pumps, pilot study	64	hrs	2 days, 8 hours a day, 80% utilization, 1 hp pumps, 5 pumps
Pumps, full treatment	1280	hrs	10 days, 8 hours a day, 80% utilization, 1 hp pumps, 20 pumps

LTM

Transportation-Personnel

Item	Quantity	Units	Comments
Yearly site inspection	1,500.00	miles	1 day per visit, 50 miles per day, 1 person, for years 1 through 30
Sample collections	12,560.00	miles	4 days per visit, 50 miles per day, 2 people, 4 times a year for year 1, two times a year for years 2 and 3, one time a year for years 4 through 30
5 year review	300	miles	1 day per visit, 50 miles per day, 1 person, for years 5,10,15,20,25,30

Laboratory Analytical Services

Item	Quantity	Units	Comments
Water Analysis	$56,000.00	dollars	8 samples per visit, 4 visits year 1, 2 visits year 2 and 3, 1 visit years 4 through 30, $200 per sample

Alternative G-2a: Full Plume In-Situ Chemical Oxidation, Monitoring, LUCs

RAC

Materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Decontamination water	3,000.00	gallons	
Injection Well Instalation	302.40	lb	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	125.00	lb	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation	4,939.20	lb	6860 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	1,000.00	lb	Assume PVC, 25 lb per unit, Assume 40 units

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent transportation	4,000	miles	80 days, 50 miles per day, 1 person
Site Health and Safety/QC	1,500	miles	30 days, 50 miles per day, 1 person
Site Support Labor	2,500	miles	25 days, 50 miles per day, 2 people
Bench Test labor	250	miles	5 days, 50 miles per day, 1 person
Pilot Study: injection labor	200	miles	2 days, 50 miles per day, 2 people
Pilot Study: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Full Treatment: injection labor	2,800	miles	14 days, 50 miles per day, 4 people
Full treatment: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Baseline sampling	3,000	miles	15 days, 50 miles per day, 4 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	20.00	ton	2 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.90	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 lb per 500 gal capacity tank
Clean Water Storage Tank	0.60	ton	4000 gallons capacity HPDE, 100 miles round trip
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.01	ton	22 lb per auger,
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.01	ton	22 lb per auger,

Transportation-materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection Well Instalation	0.15	ton	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.06	ton	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation	2.47	ton	6860 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.50	ton	Assume PVC, 25 lb per unit, Assume 40 units

Equipment Use

Item	Quantity	Units	Comments
DPT Drill Rig	15.36	hours	5 wells per day, 12 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	12	hours	1 hour per well, 12 wells,
DPT Drill Rig	250.88	hours	5 wells per day, 196 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	196	hours	1 hour per well, 196 wells,

Residual Handling

Item	Quantity	Units	Comments
Decontamination water	12.48	ton	3,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	0.46	ton	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	4.17	ton	184 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Transportation-residual handling

Item	Quantity	Units	Comments
Decontamination water	100	miles	2,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	100.00	miles	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	100.00	miles	184 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Laboratory Analytical Services

Item	Quantity	Units	Comments
Bench Test Analysis	$1,000.00	dollars	5 samples, $200 per sample
Pilot Study Sampling	$1,000.00	dollars	5 samples, $200 per sample
Full Treatment Sampling	$1,000.00	dollars	5 samples, $200 per sample
Baseline Sampling	$19,200.00	dollars	12 events, 8 samples per event, $200 per sample

RAO

Materials

Item	Quantity	Units	Comments
ISCO Reagent	254,100.00	lb	Asssume hydrogen peroxide, 21,000 gallons, density 12.100 ppg
ISCO Injection Water	17,000.00	gallons	
ISCO Reagent	4,380,200.00	lb	Asssume hydrogen peroxide, 362,000 gallons, density 12.100 ppg
ISCO Makeup Water	286,000.00	gallons	

Transportation-equipment

Item	Quantity	Units	Comments
Pumps, pilot study	0.10	ton	5 pumps, 39 lb per pump, 100 miles round trip
Pumps, full treatment	0.78	ton	40 pumps, 39 lb per pump, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
ISCO Reagent	127.05	ton	Asssume hydrogen peroxide, 21,000 gallons, density 12.100 ppg
ISCO Injection Water	70.72	ton	
ISCO Reagent	2,190.10	ton	Asssume hydrogen peroxide, 362,000 gallons, density 12.100 ppg
ISCO Makeup Water	1,189.76	ton	

Equipment Use

Item	Quantity	Units	Comments
Pumps, pilot study	64	hrs	2 days, 8 hours a day, 80% utilization, 1 hp pumps, 5 pumps
Pumps, full treatment	3584	hrs	14 days, 8 hours a day, 80% utilization, 1 hp pumps, 40 pumps

LTM

Transportation-Personnel

Item	Quantity	Units	Comments
Yearly site inspection	1,500.00	miles	1 day per visit, 50 miles per day, 1 person, for years 1 through 30
Sample collections	12,560.00	miles	4 days per visit, 50 miles per day, 2 people, 4 times a year for year 1, two times a year for years 2 and 3, one time a year for years 4 through 30
5 year review	300	miles	1 day per visit, 50 miles per day, 1 person, for years 5,10,15,20,25,30

Laboratory Analytical Services

Item	Quantity	Units	Comments
Water Analysis	$56,000.00	dollars	8 samples per visit, 4 visits year 1, 2 visits year 2 and 3, 1 visit years 4 through 30, $200 per sample

Alternative G-3: Enhanced Bioremediation, MNA, LUCs

RAC

Materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Decontamination water	2,000.00	gallons	
Injection Well Instalation	302.40	lb	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	125.00	lb	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation (EOS)	1,915.20	lb	2660 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	400.00	lb	Assume PVC, 25 lb per unit, Assume 16 units

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent transportation	3,000	miles	60 days, 50 miles per day, 1 person
Site Health and Safety/QC	1,000	miles	20 days, 50 miles per day, 1 person
Site Support Labor	2,000	miles	20 days, 50 miles per day, 2 people
Bench Test labor	250	miles	5 days, 50 miles per day, 1 person
Pilot Study: injection labor	200	miles	2 days, 50 miles per day, 2 people
Pilot Study: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Full Treatment: injection labor	1,400	miles	7 days, 50 miles per day, 4 people
Full treatment: post injection sampling labor	1,600	miles	8 days, 50 miles per day, 4 people
Baseline sampling	2,000	miles	10 days, 50 miles per day, 4 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	20	ton	2 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 lb per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.011	ton	22 lb per auger,
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.011	ton	22 lb per auger,

Transportation-materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection Well Instalation	0.15	ton	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.06	ton	Assume PVC, 25 lb per unit, Assume 5 units
Injection Well Instalation (EOS)	0.96	ton	2660 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
Injection well heads	0.20	ton	Assume PVC, 25 lb per unit, Assume 16 units

Equipment Use

Item	Quantity	Units	Comments
DPT Drill Rig	15.36	hours	5 wells per day, 12 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	12	hours	1 hour per well, 12 wells,
DPT Drill Rig	97.28	hours	5 wells per day, 76 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	76	hours	1 hour per well, 76 wells,

Residual Handling

Item	Quantity	Units	Comments
Decontamination water	8.32	ton	2,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	0.46	ton	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	2.93	ton	152 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Transportation-residual handling

Item	Quantity	Units	Comments
Decontamination water	100	miles	2,000 gallons, 8.32 pounds per gallon, 2000 pounds per ton
IDW Disposal	100.00	miles	24 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
IDW Disposal	100.00	miles	152 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)

Laboratory Analytical Services

Item	Quantity	Units	Comments
Bench Test Analysis	$1,600.00	dollars	8 samples, $200 per sample
Pilot Study Sampling	$1,000.00	dollars	5 samples, $200 per sample
Full Treatment Sampling	$1,000.00	dollars	5 samples, $200 per sample
Baseline Sampling	$3,200.00	dollars	2 events, 8 samples per event, $200 per sample

RAO

Materials

Item	Quantity	Units	Comments
EOS Reagent	6,727.49	lb	Asssume vegetable Oil, 615 gallons, density 10.939 ppg
EOS Injection Water	5,535.00	gallons	
EOS Reagent	47,420.57	lb	Asssume vegetable oil, 4,335 gallons, density 10.939 ppg
EOS Makeup Water	39,015.00	gallons	
ORC Reagent	150.00	lb	Assume limestone
ORC Makeup Water	60.00	gallons	
EOS Reagent	296,009.34	lb	Asssume vegetable Oil, density 10.939 ppg, 4510 gallons per year, for year 5, 10, 15, 20, 25 and 30
EOS Injection Water	40,590.00	gallons	40,590 gallons per year, for year 5, 10, 15, 20, 25 and 30

Transportation-Personnel

Item	Quantity	Units	Comments
Injection labor	3,000.00		5 days, 50 miles per day, 2 people, for year 5, 10, 15, 20, 25 and 30

Transportation-equipment

Item	Quantity	Units	Comments
Pumps: pilot study	0.10	ton	5 pumps, 39 lb per pump, 100 miles round trip
Pumps: full treatment	0.31	ton	16 pumps, 39 lb per pump, 100 miles round trip
Pumps: operation	0.31	ton	16 pumps, 39 lb per pump, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
EOS Reagent	3.36	ton	Asssume vegetable Oil, 615 gallons, density 10.939 ppg
EOS Injection Water	23.03	ton	
EOS Reagent	23.71	ton	Asssume vegetable oil, 4,335 gallons, density 10.939 ppg
EOS Makeup Water	162.30	ton	
ORC Reagent	0.08	ton	Assume limestone
ORC Makeup Water	0.25	ton	
EOS Reagent	148.00	ton	Asssume vegetable Oil, density 10.939 ppg, 4510 gallons per year, for year 5, 10, 15, 20, 25 and 30
EOS Injection Water	168.85	ton	40,590 gallons per year, for year 5, 10, 15, 20, 25 and 30

Equipment Use

Item	Quantity	Units	Comments
Pumps: pilot study	64.00	hours	2 days, 8 hours a day, 80% utilization, 5 pumps 1hp
Pumps: full treatment	716.80	hours	7 days, 8 hours a day, 80% utilization, 16 pumps, 1 hp
Pumps: operation	3,072.00	hours	5 days, 8 hours a day, 80% utilization, 16 pumps, 1hp, for year 5, 10, 15, 20, 25 and 30

LTM

Transportation-Personnel

Item	Quantity	Units	Comments
Yearly site inspection	1,500.00	miles	1 day per visit, 50 miles per day, 1 person, for years 1 through 30
Sample collections	12,560.00	miles	4 days per visit, 50 miles per day, 2 people, 4 times a year for year 1, two times a year for years 2 and 3, one time a year for years 4 through 30
5 year review	300	miles	1 day per visit, 50 miles per day, 1 person, for years 5,10,15,20,25,30

Laboratory Analytical Services

Item	Quantity	Units	Comments
Water Analysis	$56,000.00	dollars	8 samples per visit, 4 visits year 1, 2 visits year 2 and 3, 1 visit years 4 through 30, $200 per sample

Alternative G-4: Natural Attenuation with Monitoring/LUCs

RAC			
Materials			
Item	Quantity	Units	Comments
Well instalation	108	lb	150 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
well heads	25.00	lb	Assume PVC, 25 lb per unit, Assume 1 units
Transportation-Personnel			
Item	Quantity	Units	Comments
Baseline sampling	2,000	miles	10 days, 50 miles per day, 4 people
MNA well installation	400	miles	2 days, 50 miles per day, 4 people
Transportation-equipment			
Item	Quantity	Units	Comments
Trailers	10.00	ton	1 trailers, 10 ton per trailer, 100 miles round trip
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip
Pavement Coring, Auger	0.01	ton	22 lb per auger,
Transportation-materials			
Item	Quantity	Units	Comments
Well instalation	0.05	ton	150 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft
well heads	0.01	ton	Assume PVC, 25 lb per unit, Assume 1 units
Equipment Use			
Item	Quantity	Units	Comments
DPT Drill Rig	7.68	hours	5 wells per day, 6 wells, 8 hours per daoy, 80% utilization
Pavement Coring, Auger	6	hours	1 hour per well, 6 wells,
Residual Handling			
Item	Quantity	Units	Comments
IDW Disposal	0.12	ton	6 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
Transportation-residual handling			
Item	Quantity	Units	Comments
IDW Disposal	100.00	miles	6 drums, 55 gallons per drum, 721 kg/m^3 (assume sludge)
Laboratory Analytical Services			
Item	Quantity	Units	Comments
Baseline Sampling	$3,200.00	dollars	2 events, 8 samples per event, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Yearly site inspection	1,500.00	miles	1 day per visit, 50 miles per day, 1 person, for years 1 through 30
Sample collections	12,560.00	miles	4 days per visit, 50 miles per day, 2 people, 4 times a year for year 1, two times a year for years 2 and 3, one time a year for years 4 through 30
5 year review	300	miles	1 day per visit, 50 miles per day, 1 person, for years 5,10,15,20,25,30
Laboratory Analytical Services			
Item	Quantity	Units	Comments
Water Analysis	$56,000.00	dollars	8 samples per visit, 4 visits year 1, 2 visits year 2 and 3, 1 visit years 4 through 30, $200 per sample

APPENDIX E-3 SITEWISE™ RESULTS

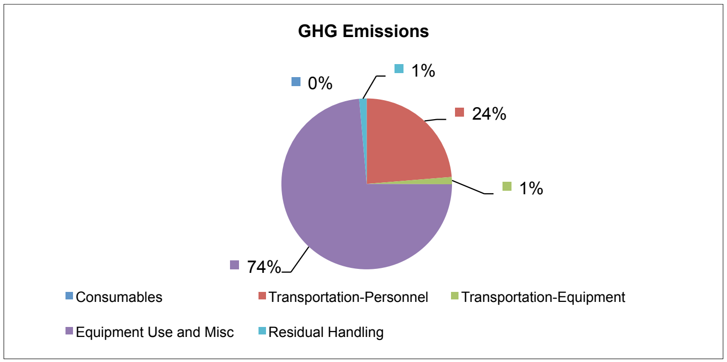
Sustainable Remediation - Environmental Footprint Summary
G-2

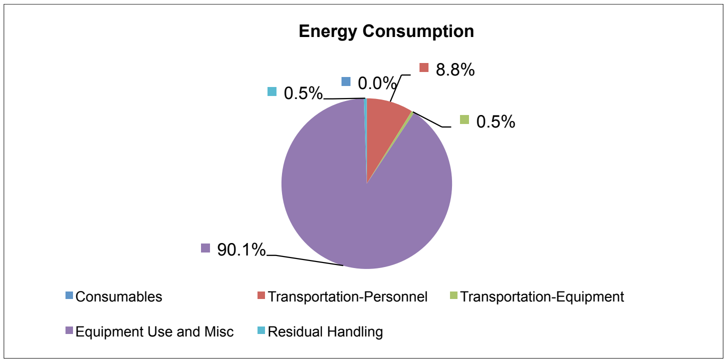
Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.20	6.5E+01	NA	1.9E-03	6.8E-05	3.9E-04	1.1E-04	8.6E-03
	Transportation-Equipment	0.30	3.9E+00	NA	9.4E-05	1.7E-06	8.4E-06	1.2E-06	9.4E-05
	Equipment Use and Misc	16.14	6.7E+02	1.1E+04	3.9E-02	2.9E-02	7.3E-03	2.5E-05	6.3E-03
	Residual Handling	0.31	4.0E+00	NA	9.7E-05	1.7E-06	8.6E-06	1.6E-06	1.3E-04
	Sub-Total	21.95	7.40E+02	1.06E+04	4.11E-02	2.86E-02	7.75E-03	1.34E-04	1.51E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	7.87	1.0E+02	NA	2.5E-03	4.4E-05	2.2E-04	2.0E-05	1.6E-03
	Equipment Use and Misc	4,667.16	1.2E+05	1.7E+05	3.9E-04	7.6E+00	2.9E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	4,675.03	1.22E+05	1.67E+05	2.87E-03	7.62E+00	2.89E+00	1.99E-05	1.60E-03
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.47	6.9E+01	NA	2.0E-03	7.1E-05	4.1E-04	1.1E-04	9.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	33.02	4.9E+02	0.0E+00	1.1E-01	7.6E-02	2.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	38.49	5.62E+02	0.00E+00	1.16E-01	7.63E-02	3.31E-03	1.12E-04	9.02E-03
Total		**4.7E+03**	**1.2E+05**	**1.8E+05**	**1.6E-01**	**7.7E+00**	**2.9E+00**	**2.7E-04**	**2.6E-02**

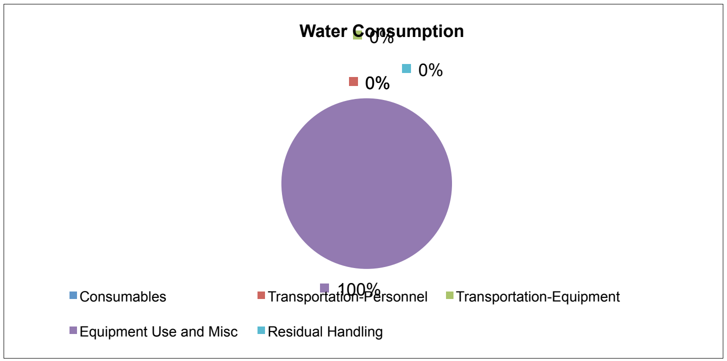
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space tons	Hazardous Waste Landfill Space tons	Topsoil Consumption cubic yards	Costing $	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.2E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	1.3E-02
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	7.2E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**2.1E-01**

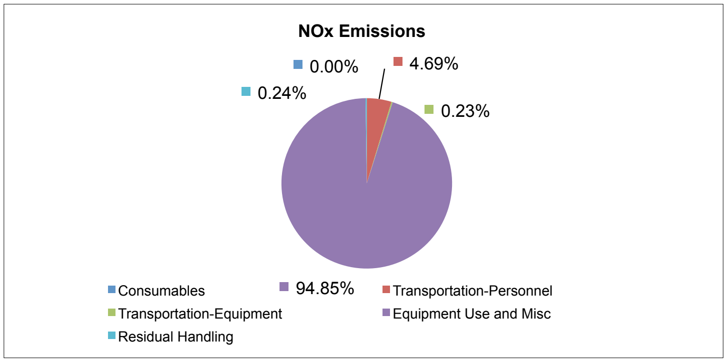
Total Cost with Footprint Reduction
$0

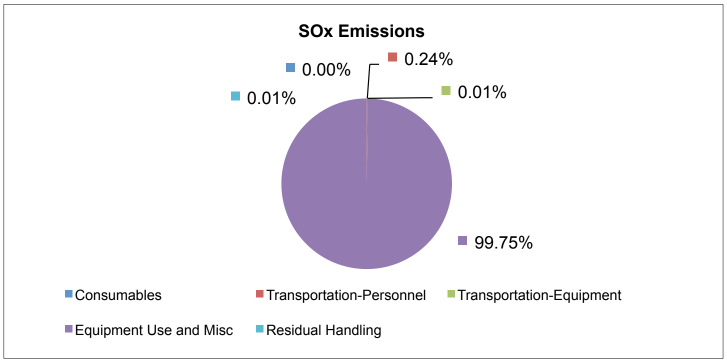
SiteWise™ Results Alternative 2
Remedial Action Constructoin Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

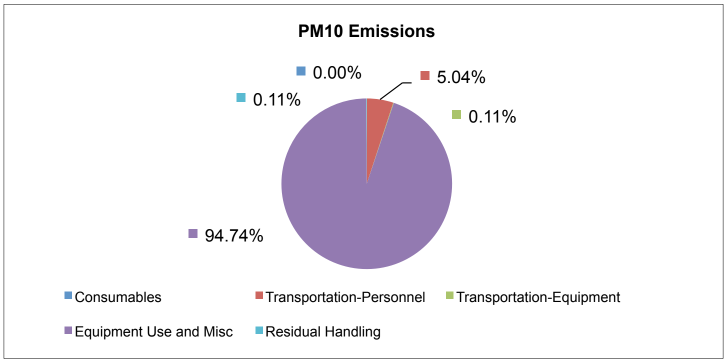


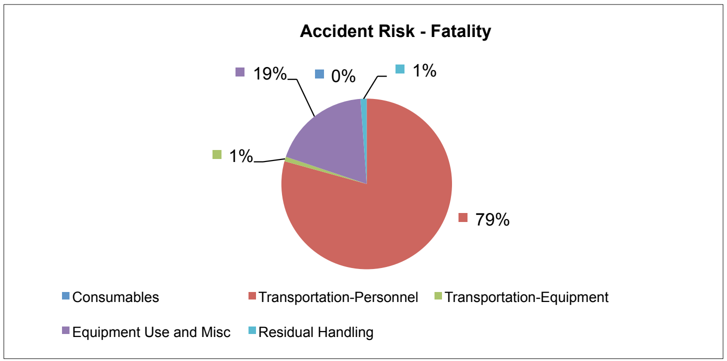


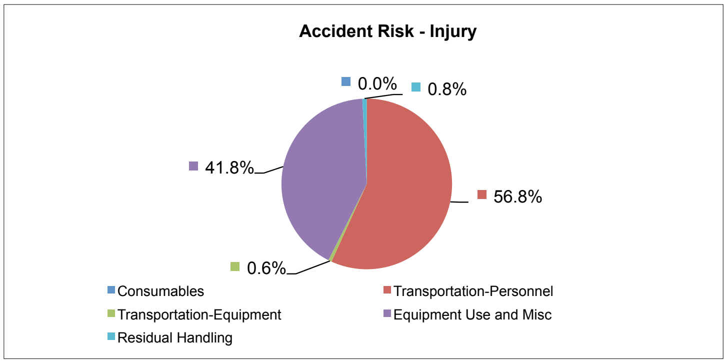


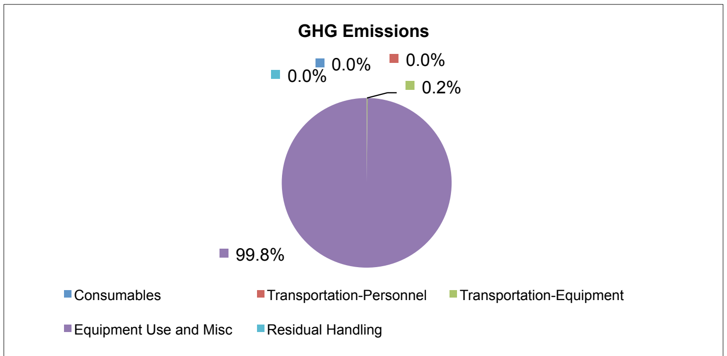











GHG Emissions
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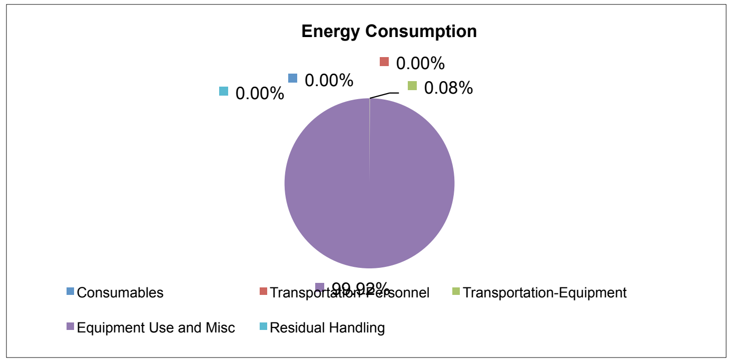
0.0%
0.0%
0.2%
99.8%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


Energy Consumption
0.00%
0.00%
0.00%
0.08%
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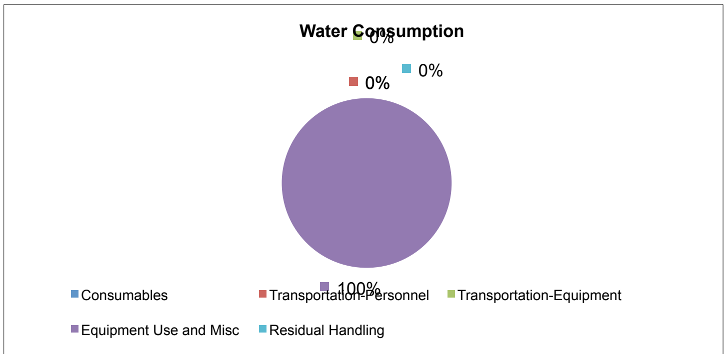
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


Water Consumption
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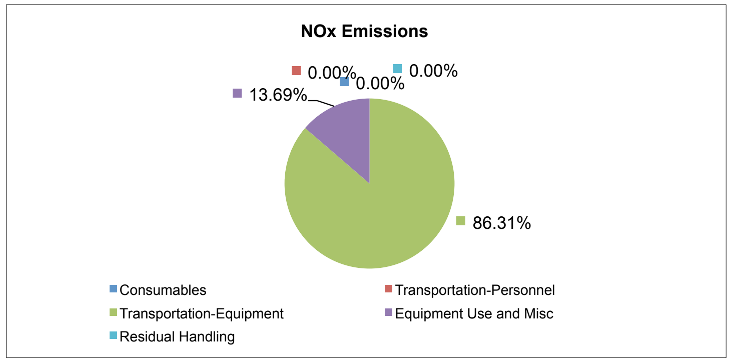
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
0.00%
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0.00%
13.69%
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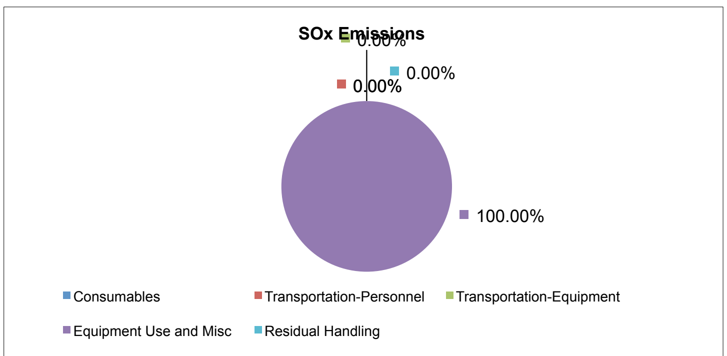
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


SOx Emissions
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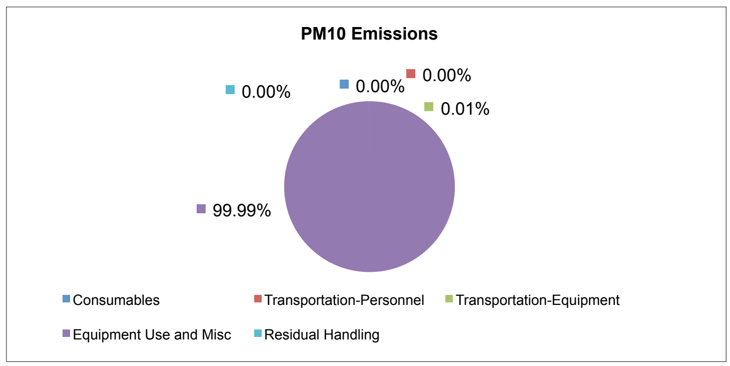
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


PM10 Emissions
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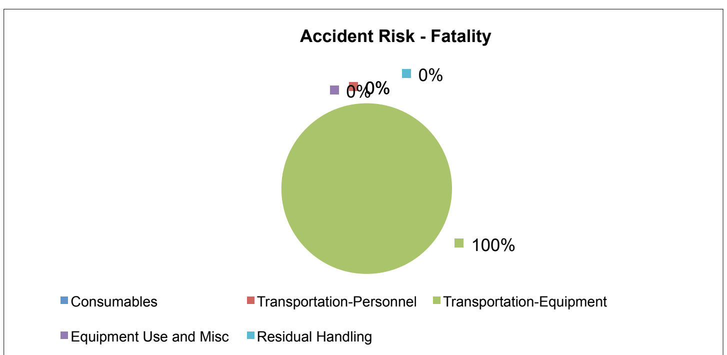
0.00%
0.00%
0.01%
99.99%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


Accident Risk - Fatality
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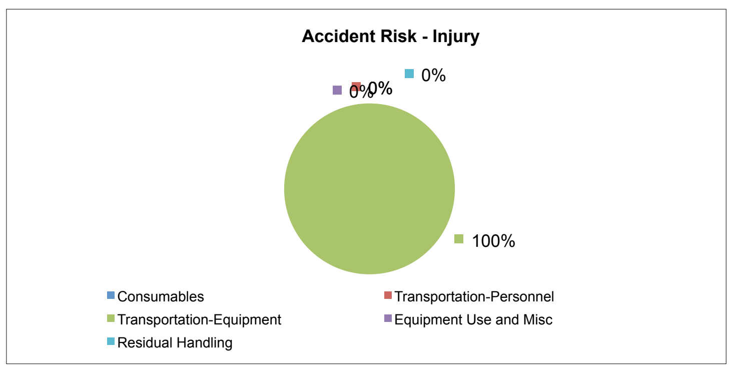
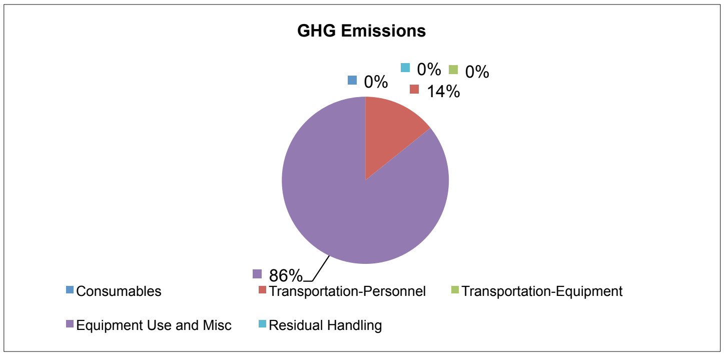
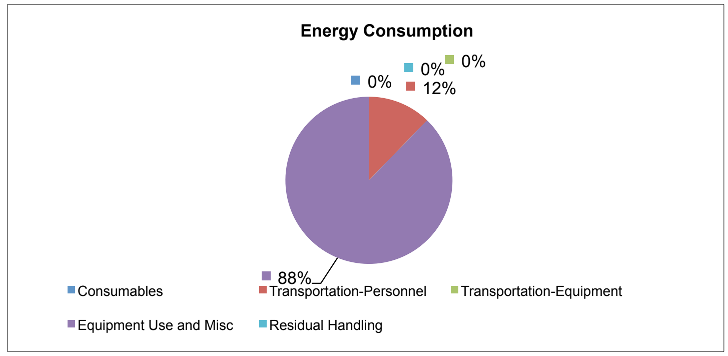
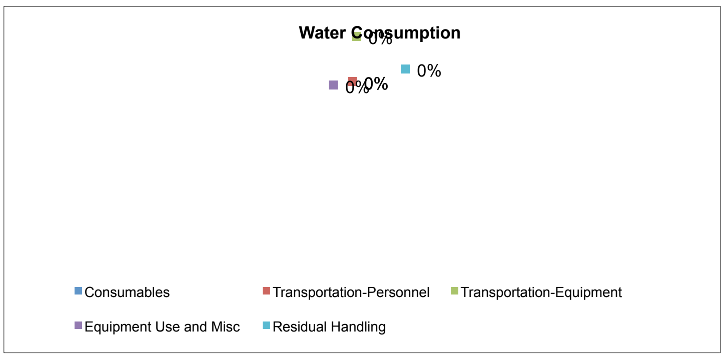
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

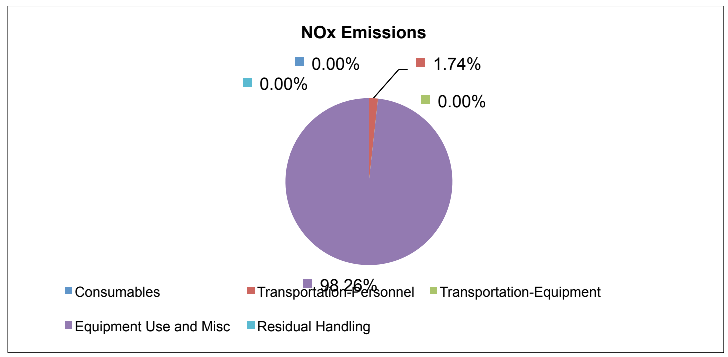

Accident Risk - Injury
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

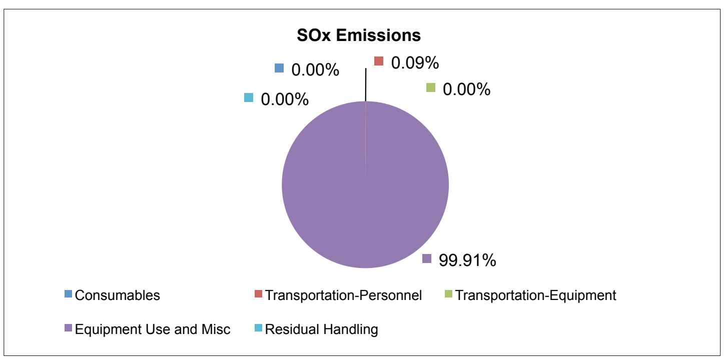
SiteWise™ Results Alternative 2
Long Term Monitoring Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

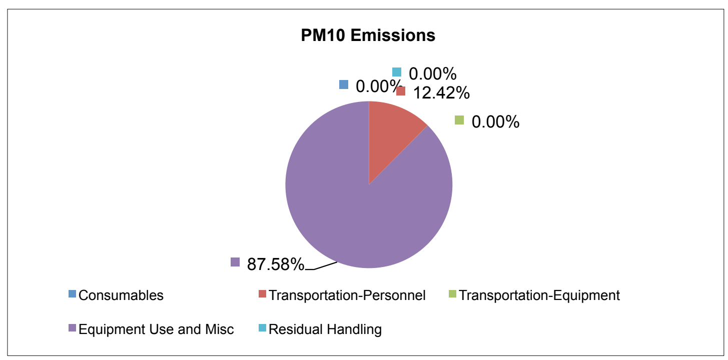


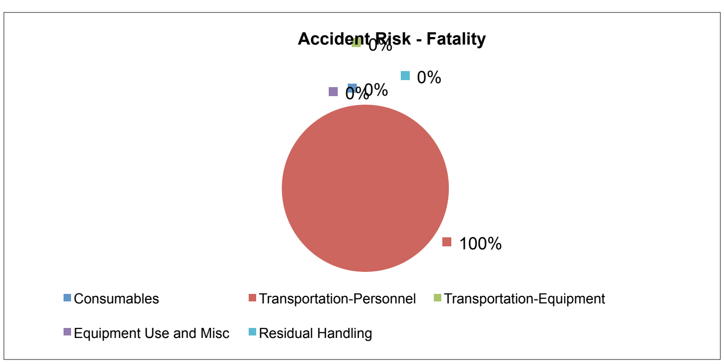


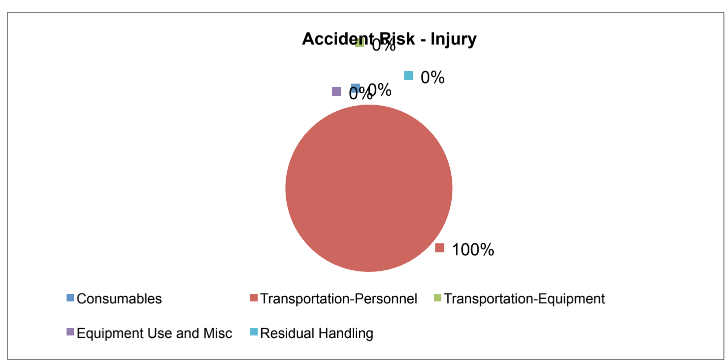




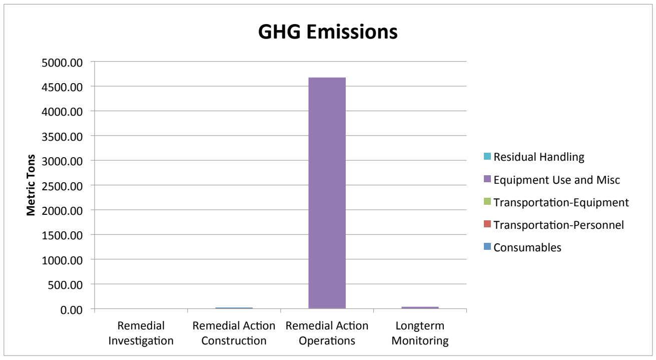


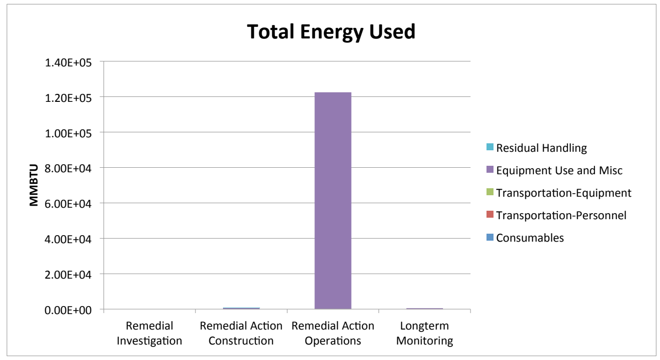


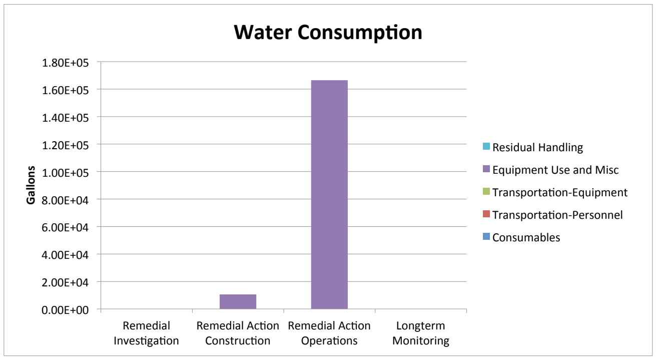


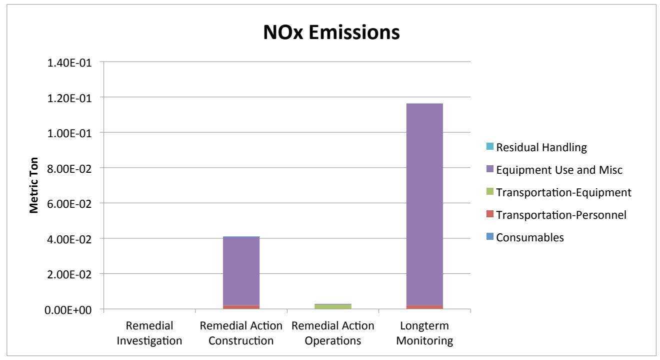


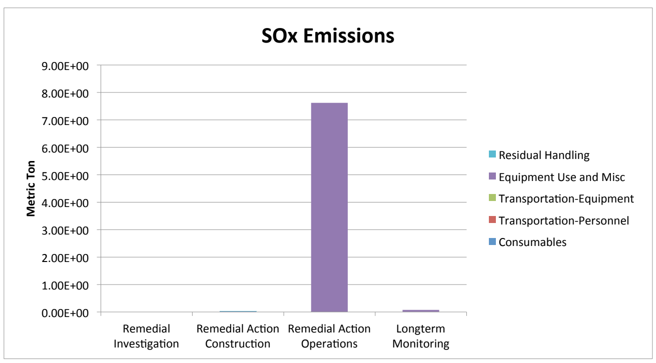
SiteWise™ Results Alternative 2
Building 82, NAS South Weymouth
Weymouth, Massachusetts

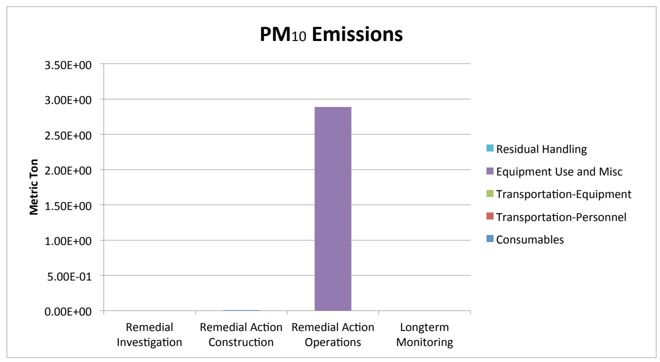


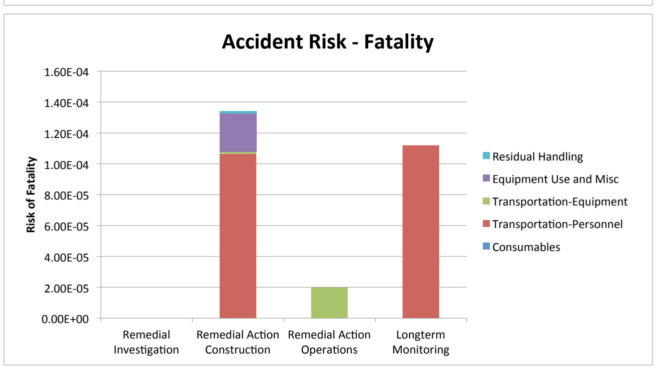


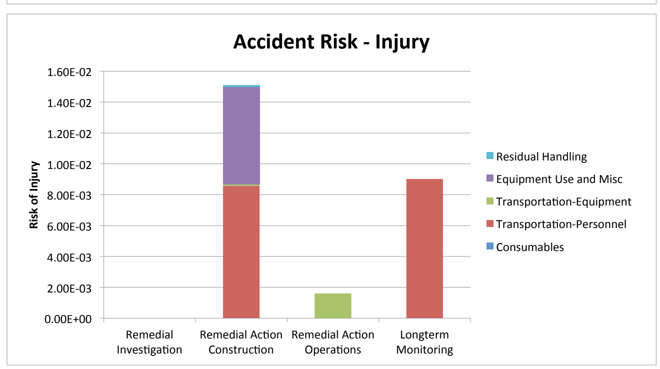


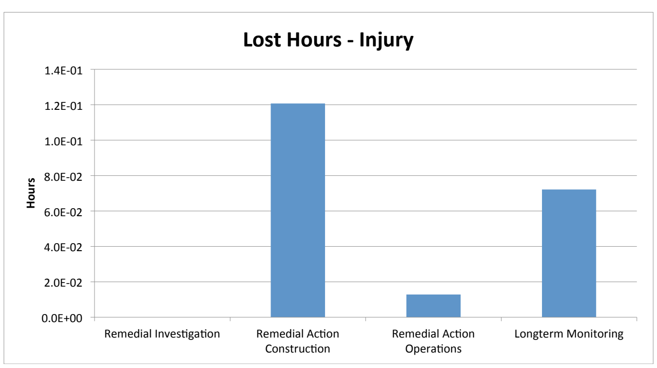












GSRx Results Alternative 2
Building 82, NAS South Weymouth
Weymouth, Massachusetts

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection Well Instalation	PVC	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	420.00	lft	0.68	0.34	0.00	0.00	0.00	0.00	0.00	12.50	0.72
RAC	Injection Well Instalation	PVC	3780 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	3,780.00	lft	6.13	3.09	0.01	0.04	0.00	0.01	0.00	112.53	6.50
RAC	Temporary Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Temporary Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 5 units	125.00	lbs	0.28	0.14	0.00	0.00	0.00	0.00	0.00	5.17	0.21
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 20 units	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAO	ISCO Reagent	Hydrogen Peroxide	Asssume hydrogen peroxide, 21,000 gallons, density 12.100 ppg	254,100.00	lbs	465.78	138.29	1.00	0.80	0.00	0.76	0.29	3579.92	0.00
RAO	ISCO Reagent	Hydrogen Peroxide	Asssume hydrogen peroxide, 189,400 gallons, density 12.100 ppg	2,291,740.00	lbs	4200.90	1247.21	9.04	7.17	0.00	6.86	2.60	32287.47	0.00
	Subtotal					**4676.47**	**1390.46**	**10.06**	**8.02**	**0.00**	**7.64**	**2.89**	**36027.44**	**8.55**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 12 wells, 8 hours per daoy, 80% utilization	15.36	hrs	0.25	0.24	0.00	0.00	0.00	0.00	0.00	1.88	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per weel, 12 wells	12.00	hrs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.06	
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 108 wells, 8 hours per daoy, 80% utilization	138.24	hrs	2.22	2.16	0.00	0.00	0.02	0.00	0.00	16.89	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 108 wells	108.00	hrs	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.52	
	Subtotal					**2.69**	**2.63**	**0.00**	**0.00**	**0.03**	**0.00**	**0.00**	**19.35**	**0**
				Total		**4,679**	**1,393**	**10.06**	**8.02**	**0.03**	**7.64**	**2.89**	**36,047**	**9**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	12.48	7.60	3.69	1.19	0.03	0.02	0.01	612.09	8,550.94
RAO	4,666.68	1,385.49	3,113.89	167.30	-	7.62	2.89	122,379.54	-
LTM	-	-	-	-	-	-	-	-	-

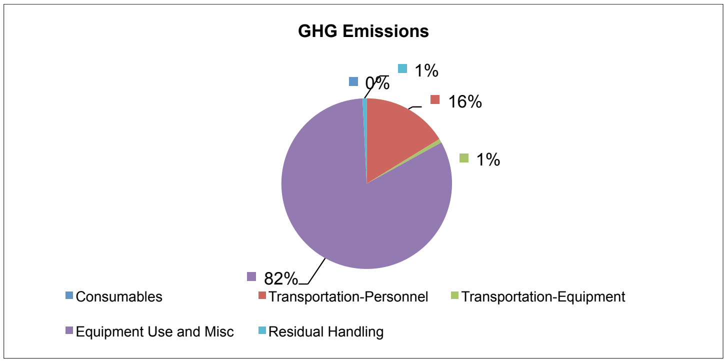
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

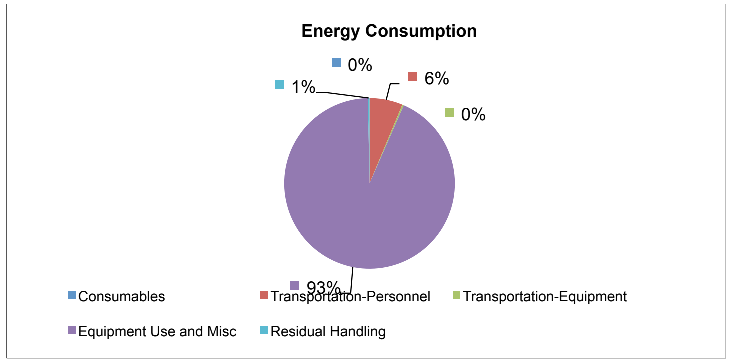
Sustainable Remediation - Environmental Footprint Summary
G-2a

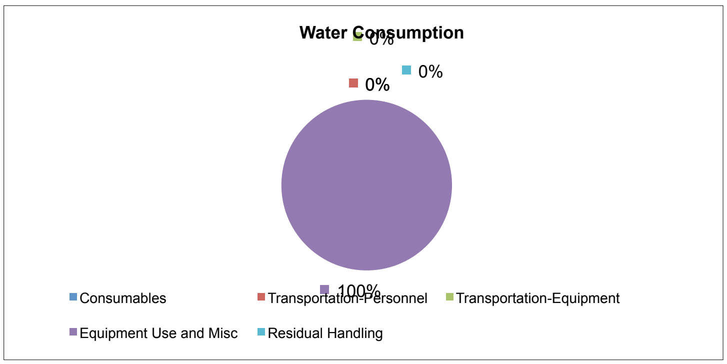
Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	6.65	8.4E+01	NA	2.5E-03	8.7E-05	5.0E-04	1.4E-04	1.1E-02
	Transportation-Equipment	0.30	3.9E+00	NA	9.5E-05	1.7E-06	8.4E-06	1.2E-06	9.4E-05
	Equipment Use and Misc	33.67	1.2E+03	1.8E+04	9.1E-02	6.3E-02	1.3E-02	4.3E-05	1.1E-02
	Residual Handling	0.32	4.2E+00	NA	1.0E-04	1.8E-06	8.9E-06	1.6E-06	1.3E-04
	Sub-Total	40.94	1.33E+03	1.77E+04	9.36E-02	6.28E-02	1.35E-02	1.82E-04	2.21E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	14.23	1.9E+02	NA	4.5E-03	7.9E-05	4.0E-04	3.6E-05	2.9E-03
	Equipment Use and Misc	8,496.26	2.2E+05	3.0E+05	1.1E-03	1.4E+01	5.3E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	8,510.49	2.23E+05	3.04E+05	5.54E-03	1.39E+01	5.25E+00	3.57E-05	2.87E-03
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.47	6.9E+01	NA	2.0E-03	7.1E-05	4.1E-04	1.1E-04	9.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	33.02	4.9E+02	0.0E+00	1.1E-01	7.6E-02	2.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	38.49	5.62E+02	0.00E+00	1.16E-01	7.63E-02	3.31E-03	1.12E-04	9.02E-03
Total		**8.6E+03**	**2.2E+05**	**3.2E+05**	**2.2E-01**	**1.4E+01**	**5.3E+00**	**3.3E-04**	**3.4E-02**

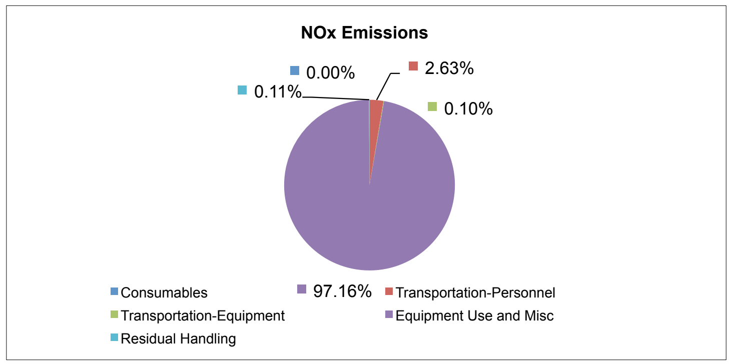
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space tons	Hazardous Waste Landfill Space tons	Topsoil Consumption cubic yards	Costing $	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.8E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	2.3E-02
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	7.2E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**2.7E-01**

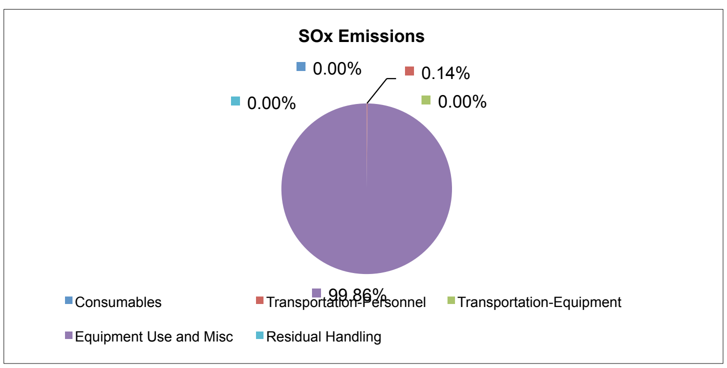
Total Cost with Footprint Reduction
$0

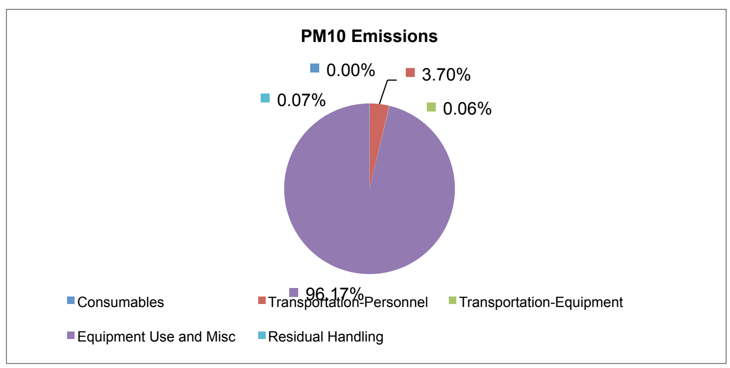

GHG Emissions
0%
1%
16%
1%
82%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

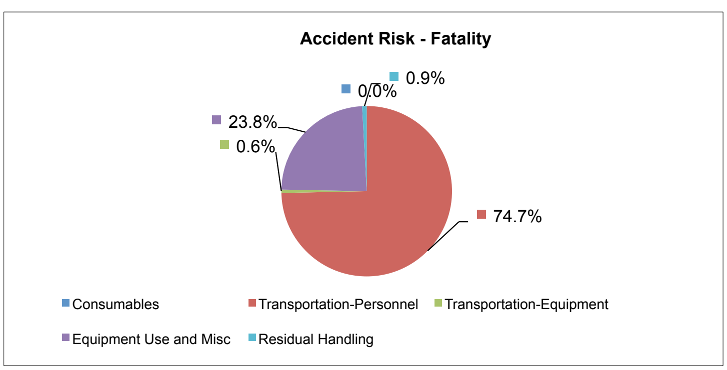

Energy Consumption
0%
6%
1%
0%
93%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

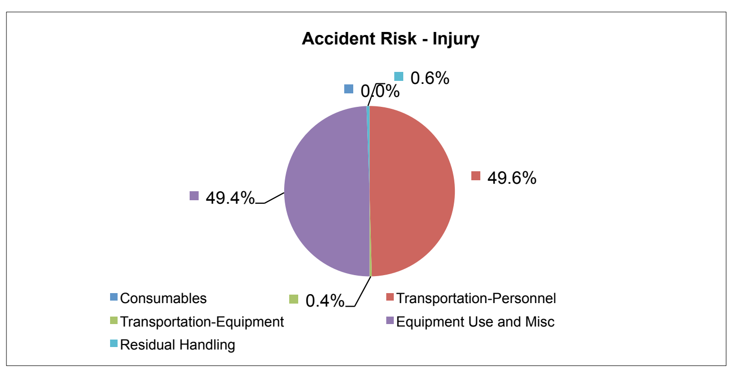

Water Consumption
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
0.00%
2.63%
0.11%
0.10%
97.16%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

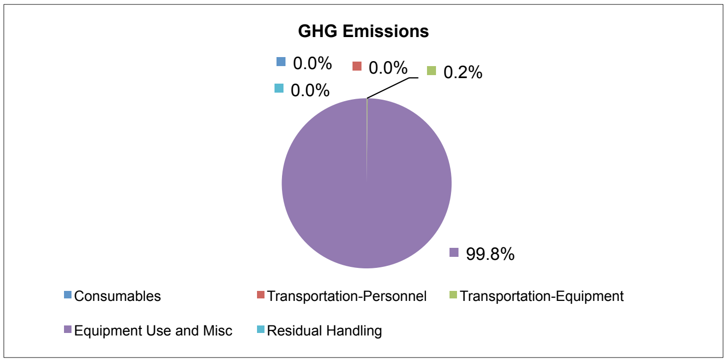

SOx Emissions
0.00%
0.14%
0.00%
0.00%
99.86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

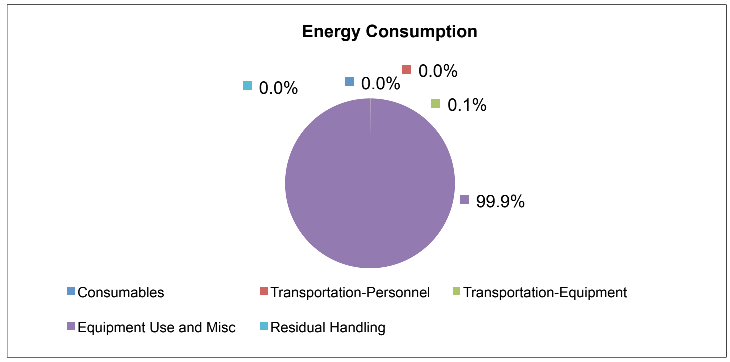

PM10 Emissions
0.00%
3.70%
0.07%
0.06%
96.17%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

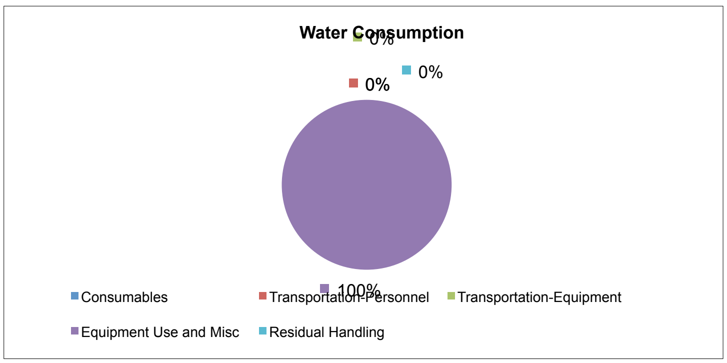

Accident Risk - Fatality
0.9%
0.0%
23.8%
0.6%
74.7%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

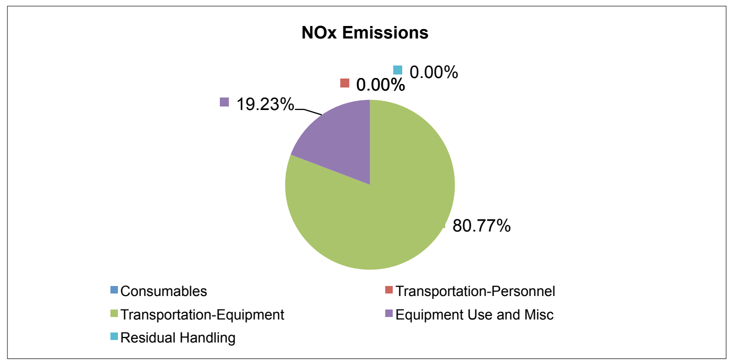

Accident Risk - Injury
0.6%
0.0%
49.6%
49.4%
0.4%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

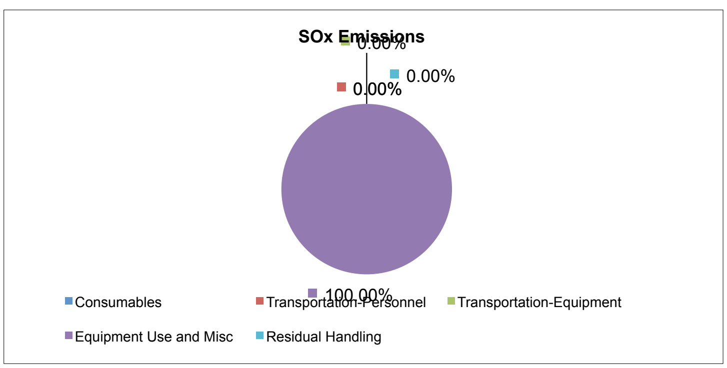
SiteWise™ Results Alternative xx
Remedial Action Operations Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

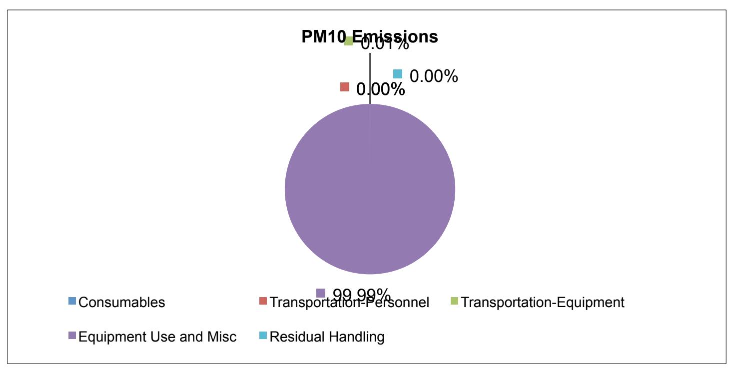


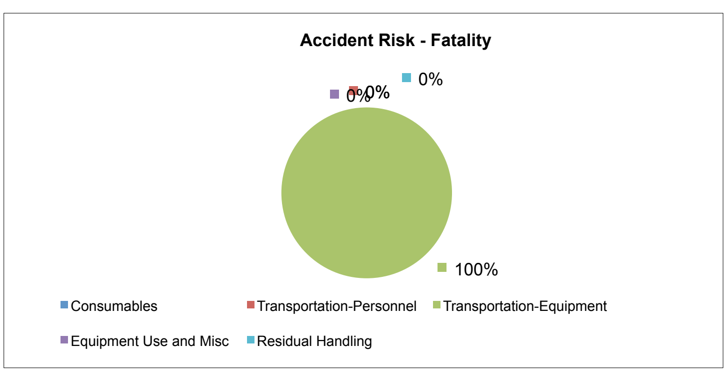


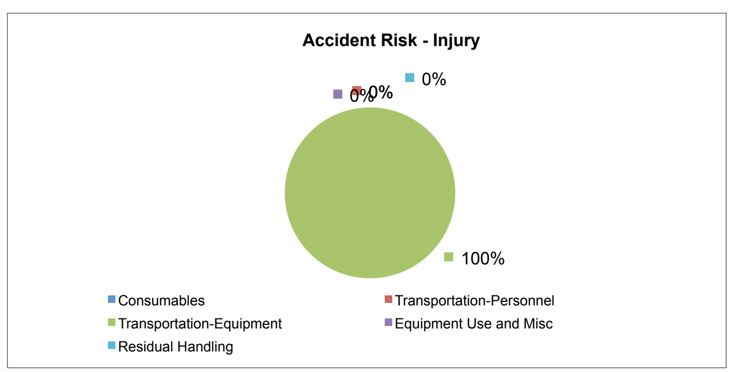




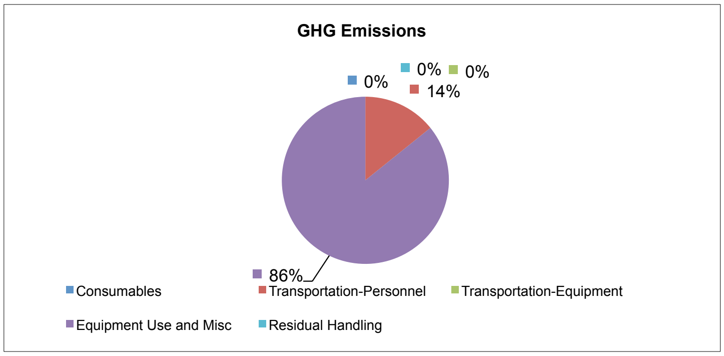


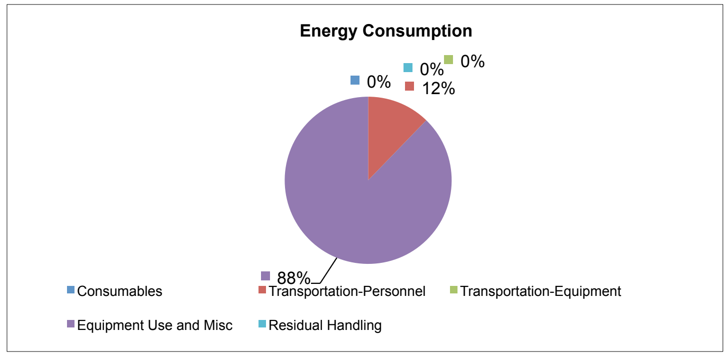


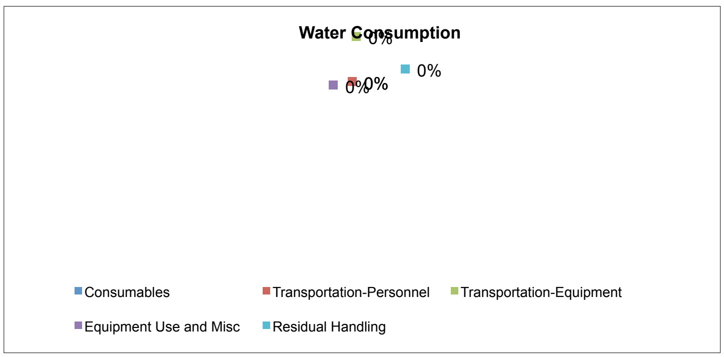


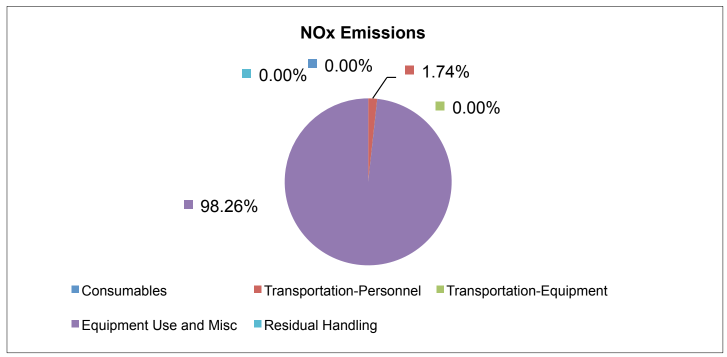


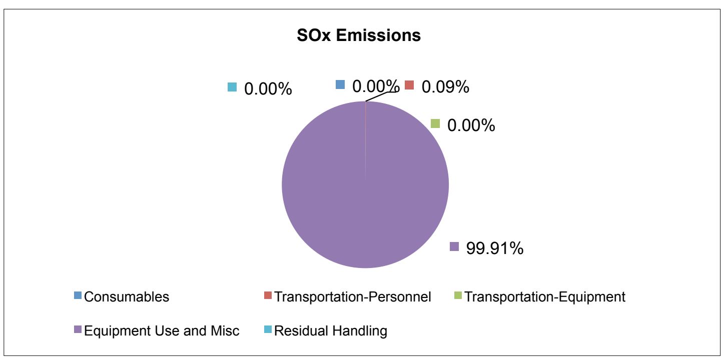
SiteWise™ Results Alternative G-2a
Long Term Monitoring Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

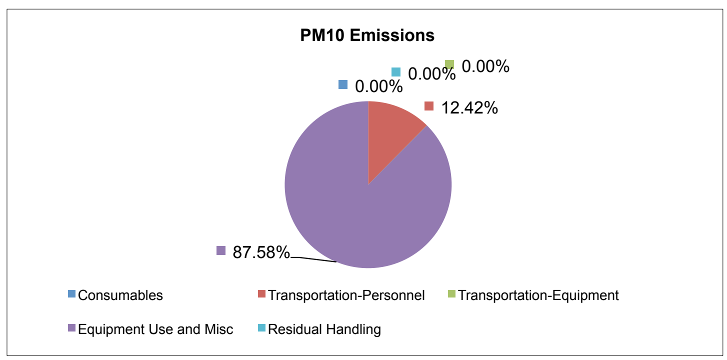


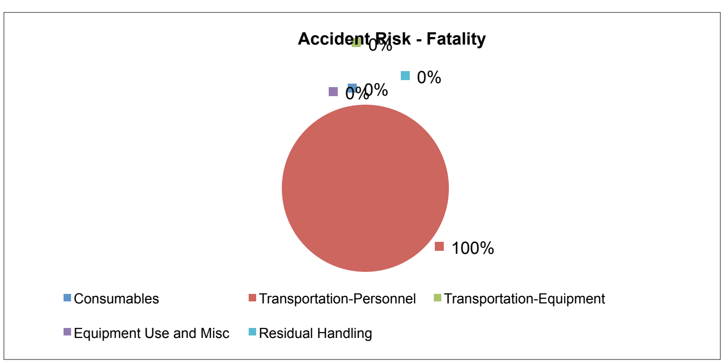


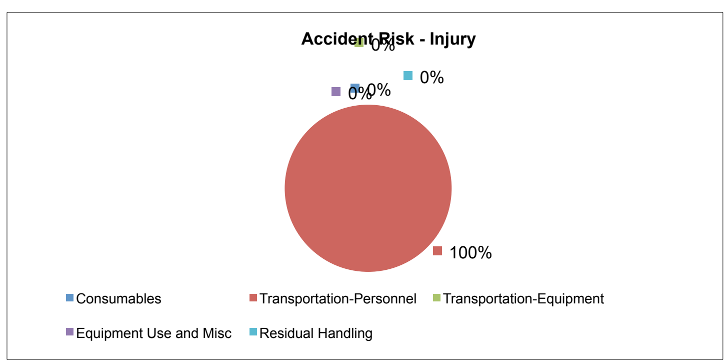


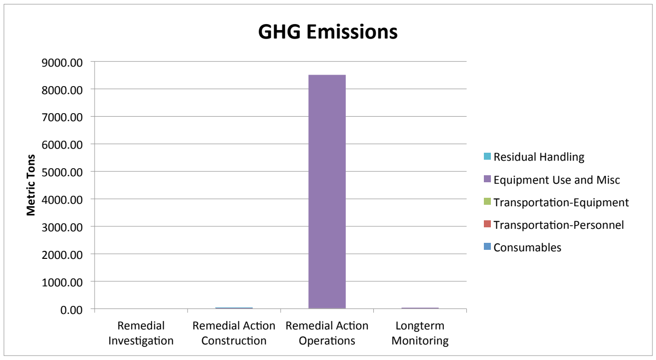


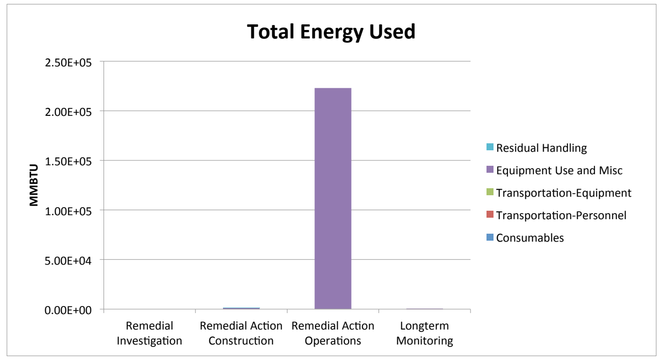


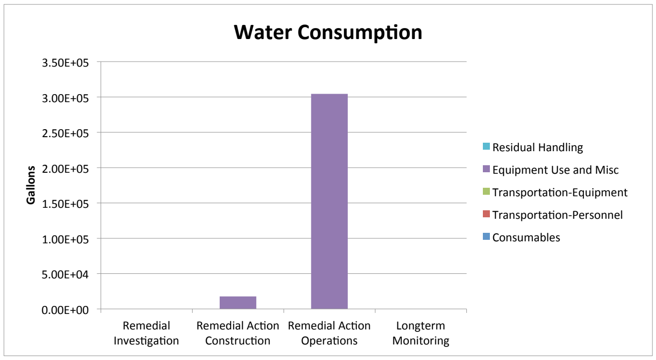


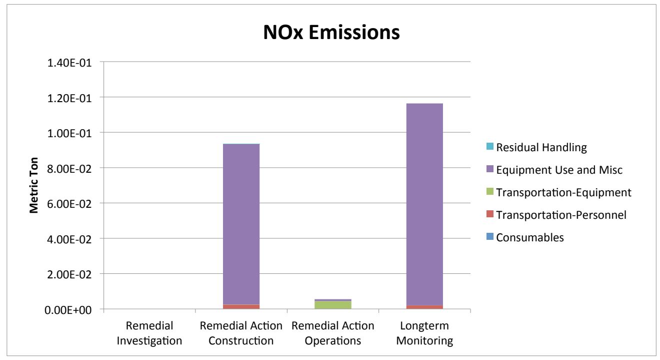





GHG Emissions
Metric Tons
9000.00
8000.00
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Total Energy Used
MMBTU
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Water Consumption
Gallons
3.50E+05
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
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1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
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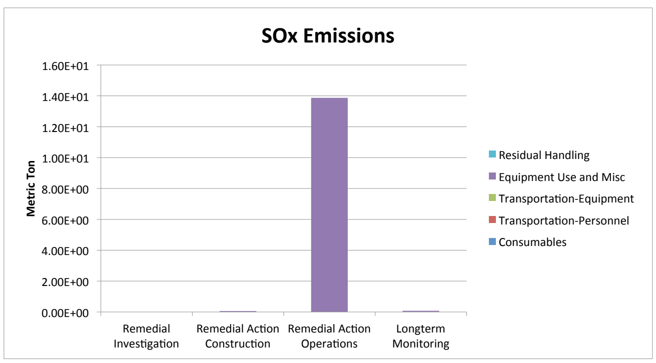
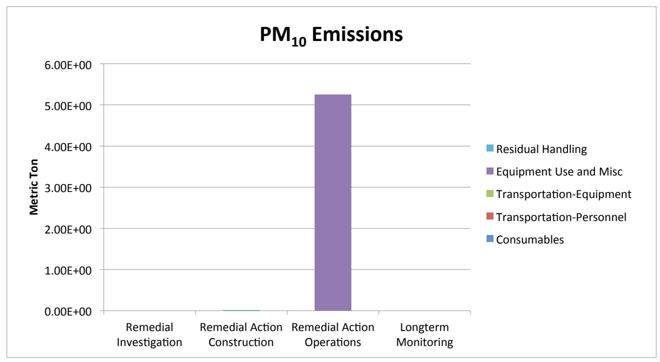
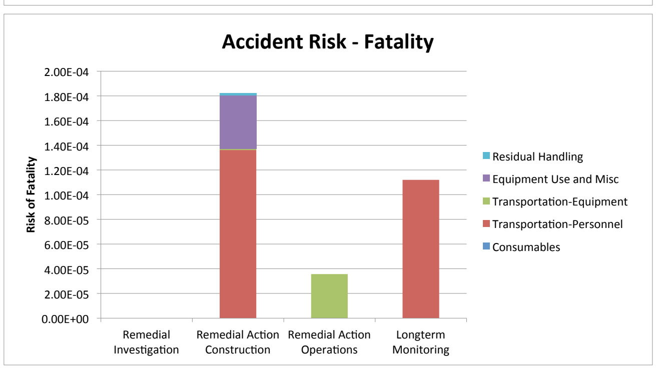
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
6.00E+00
5.00E+00
4.00E+00
3.00E+00
2.00E+00
1.00E+00
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
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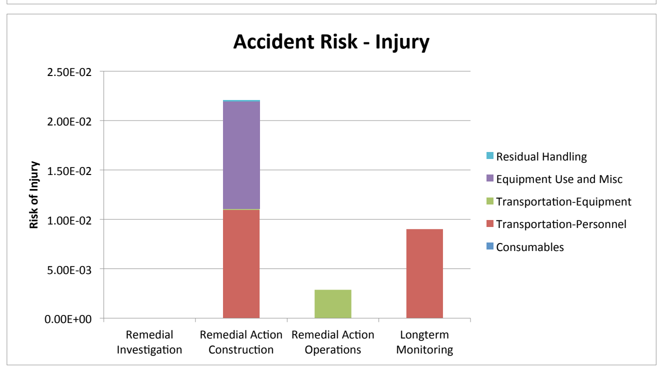
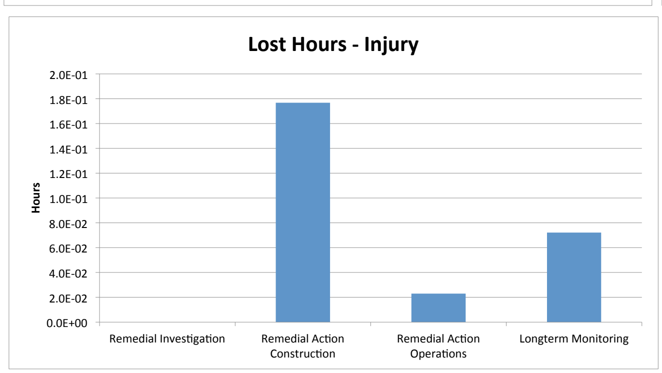
1.80E-04
1.60E-04
1.40E-04
1.20E-04
1.00E-04
8.00E-05
6.00E-05
4.00E-05
2.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Lost Hours - Injury
Hours
2.0E-01
1.8E-01
1.6E-01
1.4E-01
1.2E-01
1.0E-01
8.0E-02
6.0E-02
4.0E-02
2.0E-02
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

Stage	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions $CO_{2\ equiv}$	CO_2	N_20	CH_4	Criteria Pollutant Emission NO_x	SO_x	PM_{10}	Energy Consumption	Water Consumption
Stage	Materials								Tonnes				MWhr	gal x 1000
RAC	Injection Well Instalation	PVC	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	420.00	lft	0.68	0.34	0.00	0.00	0.00	0.00	0.00	12.50	0.72
RAC	Injection Well Instalation	PVC	6860 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	6,860.00	lft	11.13	5.60	0.01	0.06	0.00	0.02	0.00	204.22	11.80
RAC	Temporary Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Temporary Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 5 units	125.00	lbs	0.28	0.14	0.00	0.00	0.00	0.00	0.00	5.17	0.21
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 40 units	1,000.00	lbs	2.25	1.13	0.00	0.01	0.00	0.00	0.00	41.35	1.72
RAO	ISCO Reagent	Hydrogen Peroxide	Asssume hydrogen peroxide, 21,000 gallons, density 12.100 ppg	254,100.00	lbs	465.78	138.29	1.00	0.80	0.00	0.76	0.29	3579.92	0.00
RAO	ISCO Reagent	Hydrogen Peroxide	Asssume hydrogen peroxide, 362,000 gallons, density 12.100 ppg	4,380,200.00	lbs	8029.17	2383.78	17.28	13.71	0.00	13.11	4.97	61711.00	0.00
	Subtotal					**8510.87**	**2530.12**	**18.30**	**14.59**	**0.00**	**13.90**	**5.26**	**65563.34**	**14.71**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 12 wells, 8 hours per day, 80% utilization	15.36	hrs	0.25	0.24	0.00	0.00	0.00	0.00	0.00	1.88	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 12 wells,	12.00	hrs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.06	
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 196 wells, 8 hours per day, 80% utilization	250.88	hrs	4.02	3.92	0.00	0.00	0.04	0.00	0.00	30.66	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 196 wells,	196.00	hrs	0.37	0.37	0.00	0.00	0.00	0.00	0.00	0.94	
	Subtotal					**4.66**	**4.56**	**0.00**	**0.00**	**0.05**	**0.00**	**0.01**	**33.53**	**0**
				Total		**8,516**	**2,535**	**18.30**	**14.60**	**0.05**	**13.90**	**5.27**	**65,597**	**15**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions $CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	Criteria Pollutant Emission NO_x	SO_x	PM_{10}	Energy Consumption	Water Consumption
				Tonnes				MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	20.58	12.61	5.98	1.99	0.05	0.03	0.01	1,043.88	14,706.40
RAO	8,494.96	2,522.07	5,668.35	304.54	-	13.87	5.25	222,772.63	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

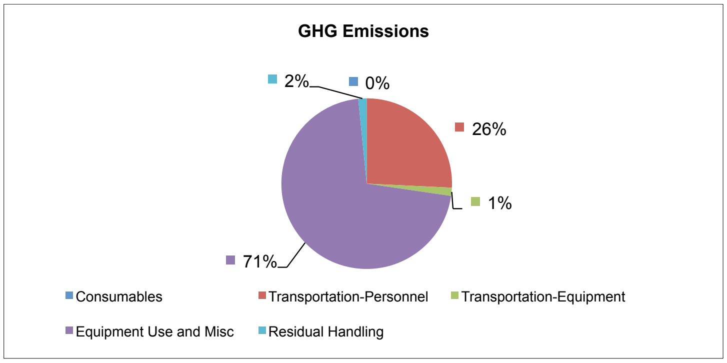
Sustainable Remediation - Environmental Footprint Summary
G-3

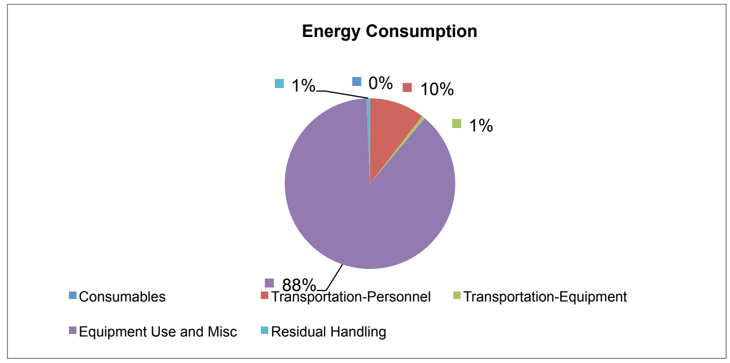
Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	4.97	6.3E+01	NA	1.8E-03	6.5E-05	3.7E-04	1.0E-04	8.2E-03
	Transportation-Equipment	0.30	3.9E+00	NA	9.4E-05	1.7E-06	8.4E-06	1.2E-06	9.4E-05
	Equipment Use and Misc	13.73	5.3E+02	8.5E+03	3.3E-02	2.5E-02	5.7E-03	1.8E-05	4.6E-03
	Residual Handling	0.31	4.0E+00	NA	9.6E-05	1.7E-06	8.6E-06	1.6E-06	1.3E-04
	Sub-Total	19.31	5.97E+02	8.45E+03	3.52E-02	2.53E-02	6.07E-03	1.23E-04	1.30E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	1.14	1.4E+01	NA	4.2E-04	1.5E-05	8.6E-05	2.3E-05	1.9E-03
	Transportation-Equipment	2.23	2.9E+01	NA	7.0E-04	1.2E-05	6.2E-05	5.9E-06	4.8E-04
	Equipment Use and Misc	53.85	6.3E+03	2.4E+05	1.1E-03	5.5E-02	5.3E-05	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	57.22	6.30E+03	2.45E+05	2.25E-03	5.52E-02	2.01E-04	2.93E-05	2.36E-03
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.47	6.9E+01	NA	2.0E-03	7.1E-05	4.1E-04	1.1E-04	9.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	33.02	4.9E+02	0.0E+00	1.1E-01	7.6E-02	2.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	38.49	5.62E+02	0.00E+00	1.16E-01	7.63E-02	3.31E-03	1.12E-04	9.02E-03
Total		**1.2E+02**	**7.5E+03**	**2.5E+05**	**1.5E-01**	**1.6E-01**	**9.6E-03**	**2.6E-04**	**2.4E-02**

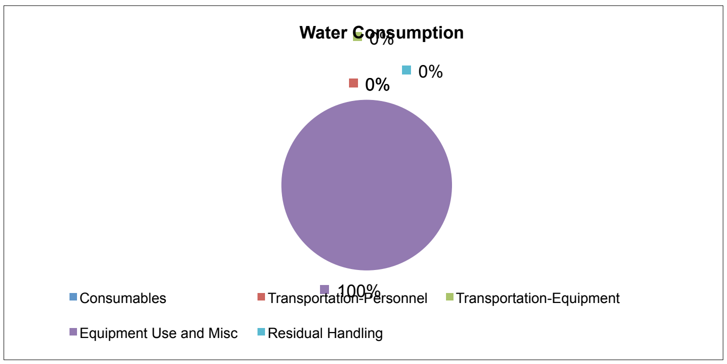
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space tons	Hazardous Waste Landfill Space tons	Topsoil Consumption cubic yards	Costing $	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.0E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	1.9E-02
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	7.2E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**2.0E-01**

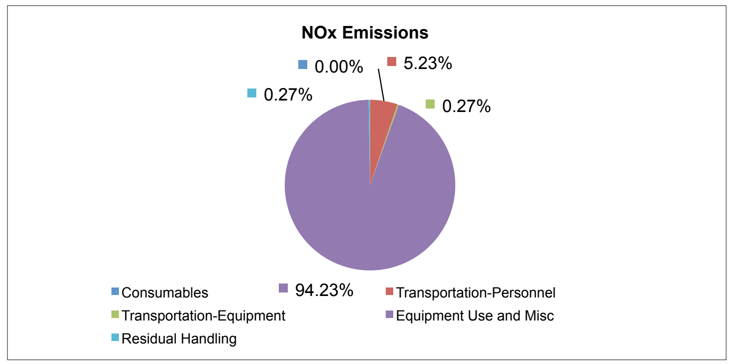
Total Cost with Footprint Reduction
$0

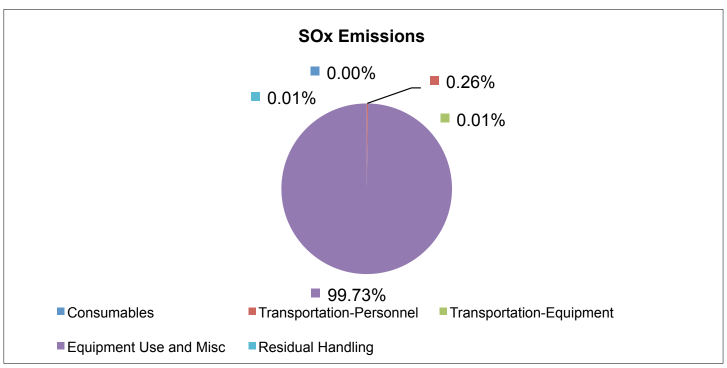
SiteWise™ Results Alternative G-3
Remedial Action Constructoin Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

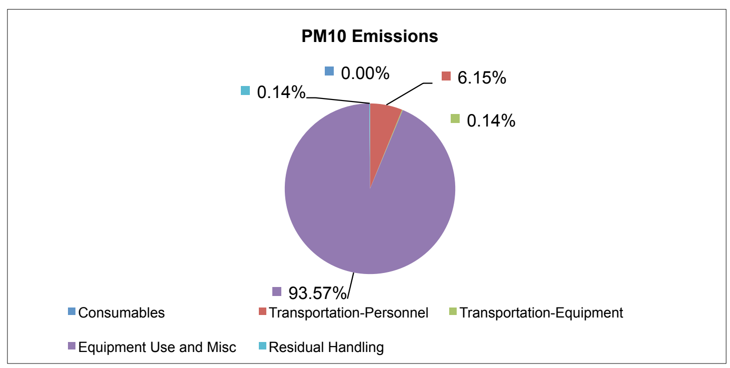


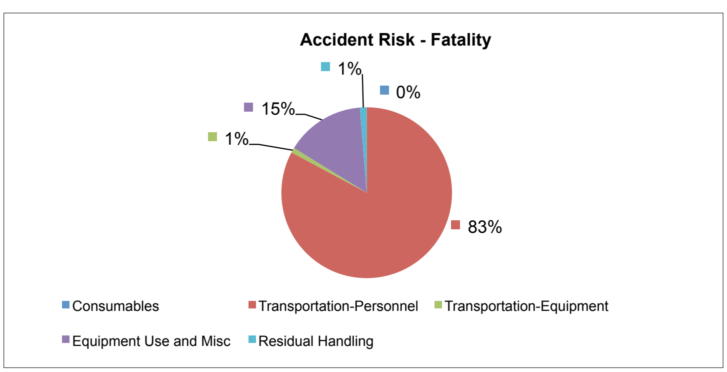


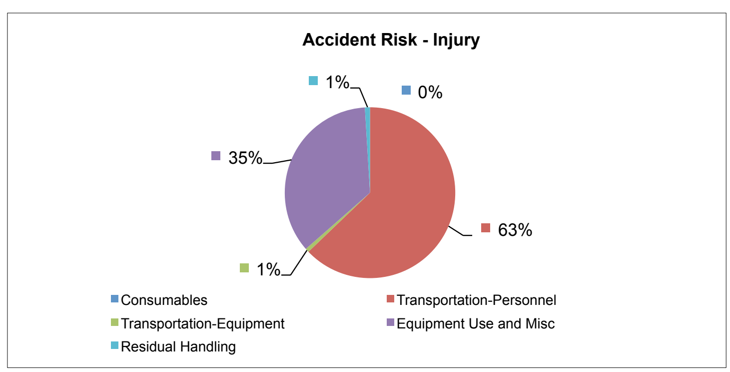




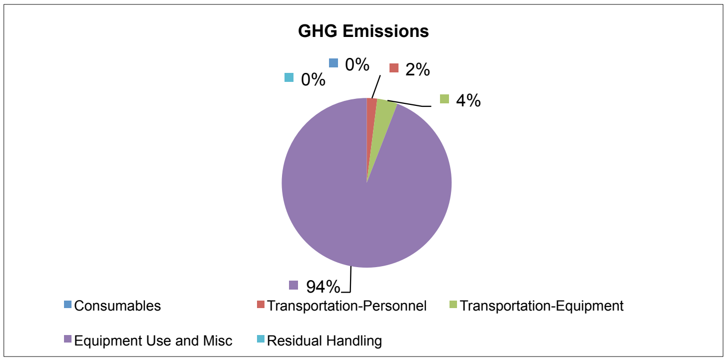


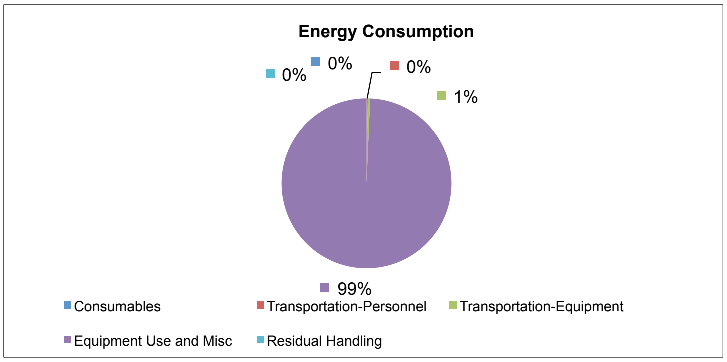


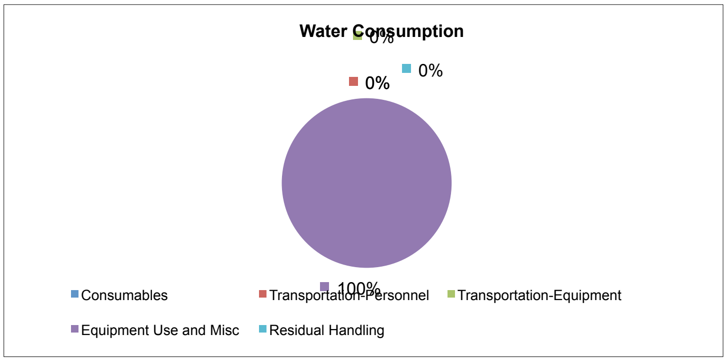


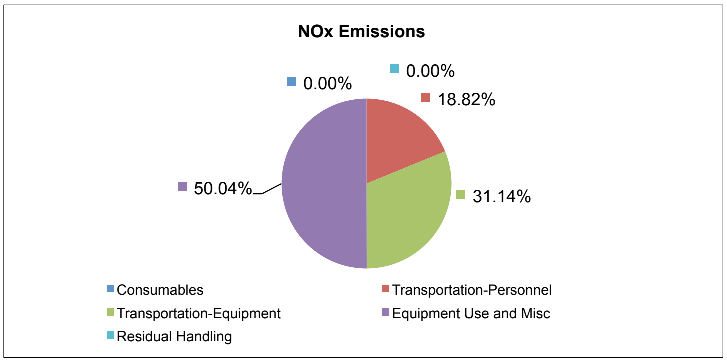


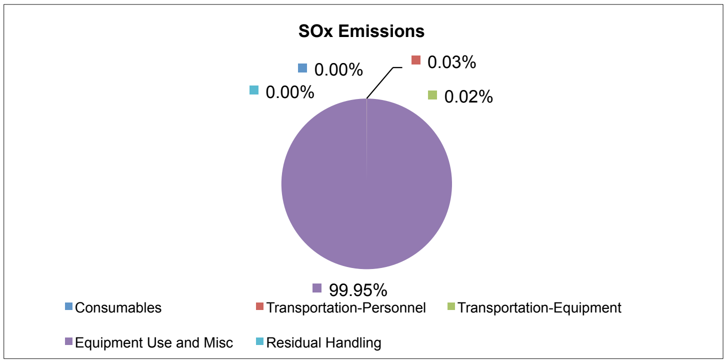
SiteWise™ Results Alternative G-3
Remedial Action Operations Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

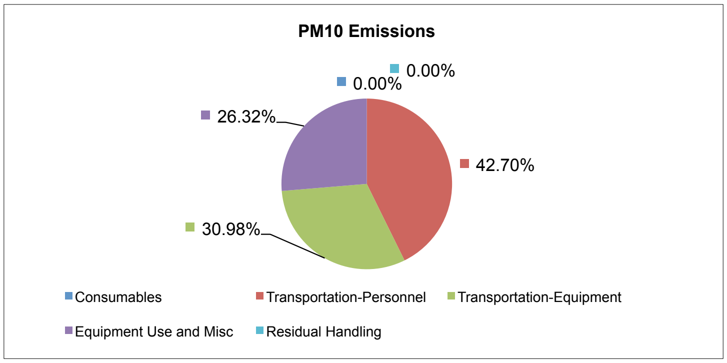


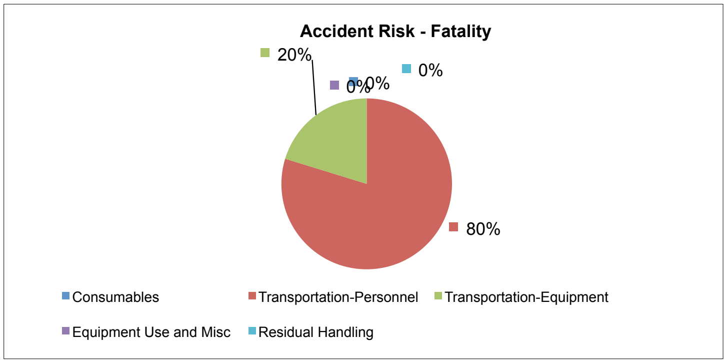


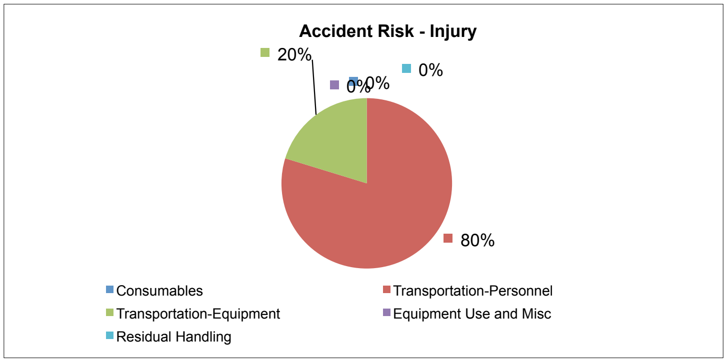




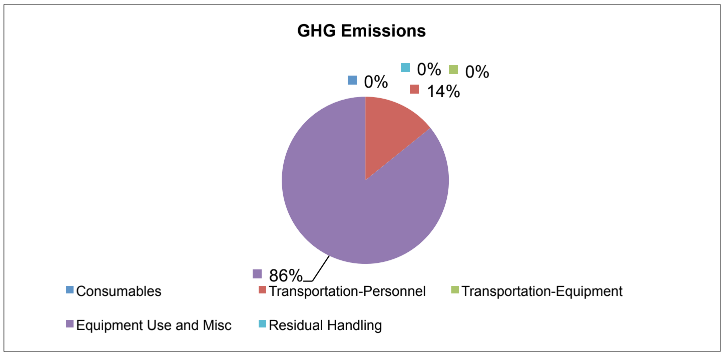


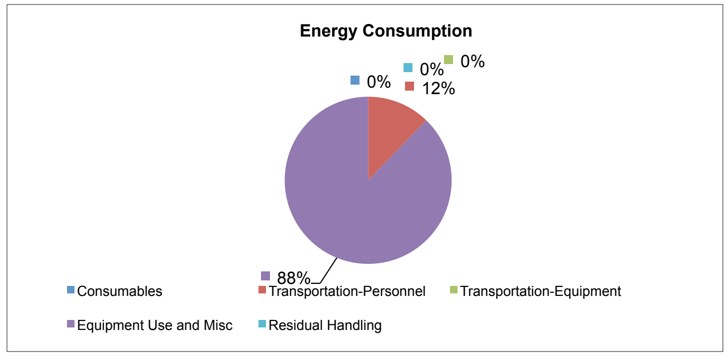


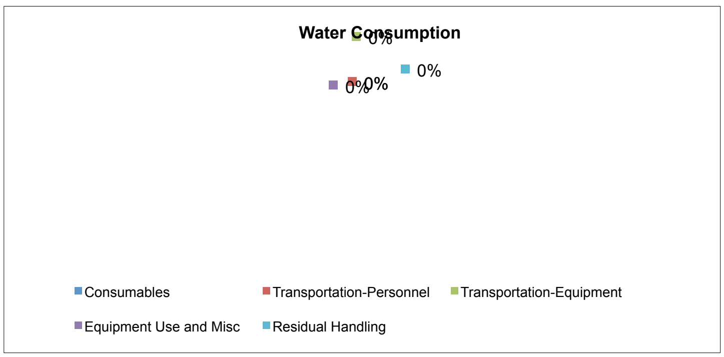


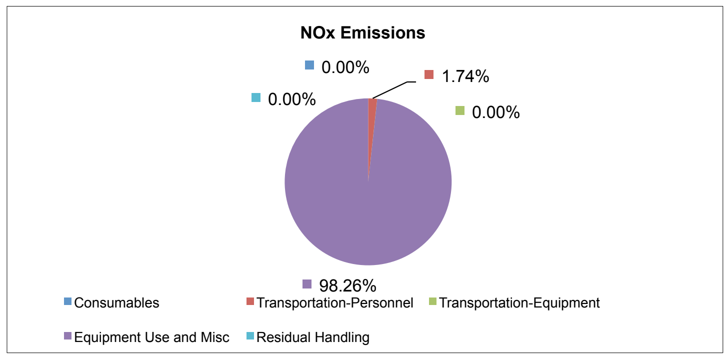


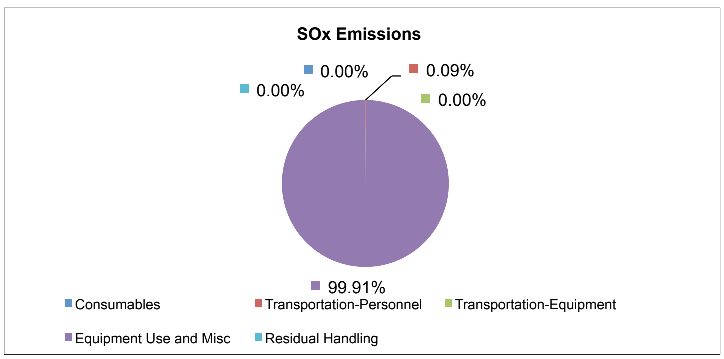
SiteWise™ Results Alternative G-3
Long Term Monitoring Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

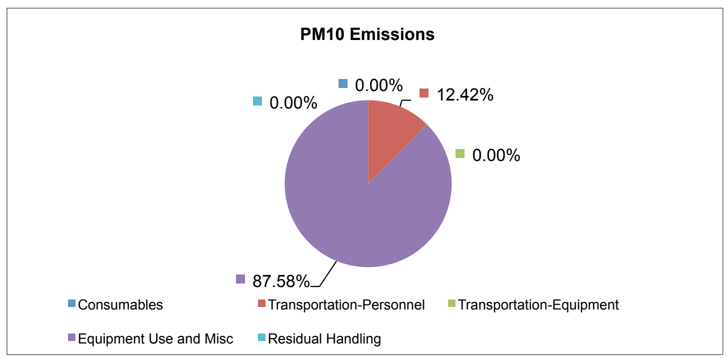


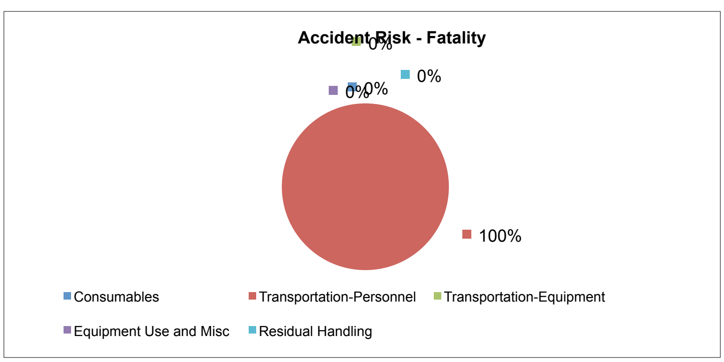


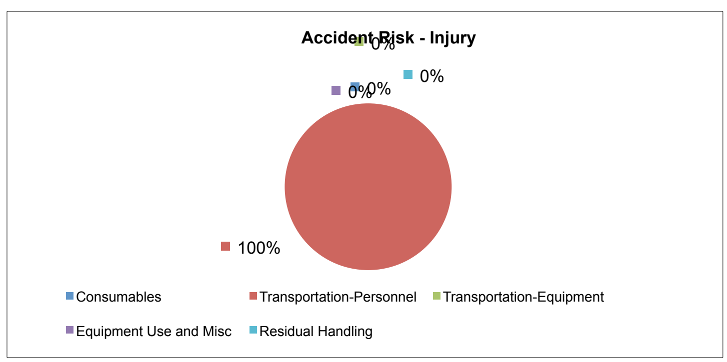


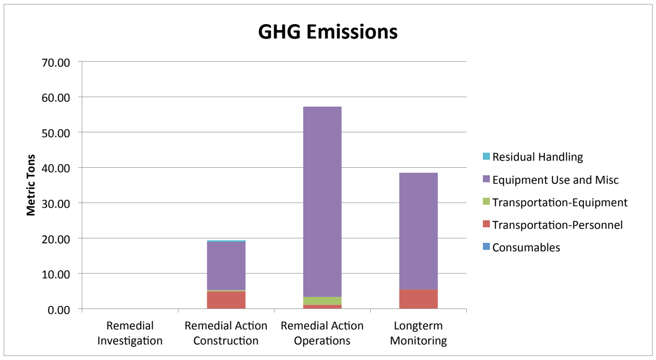


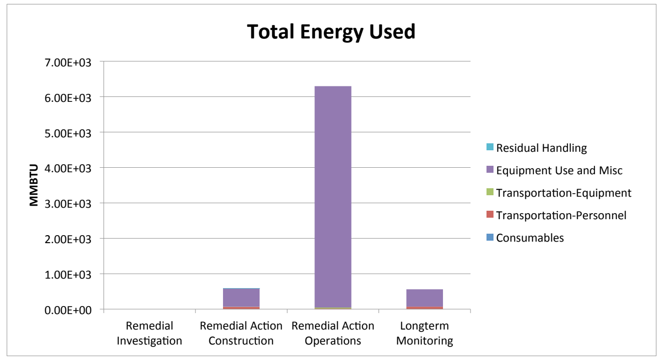


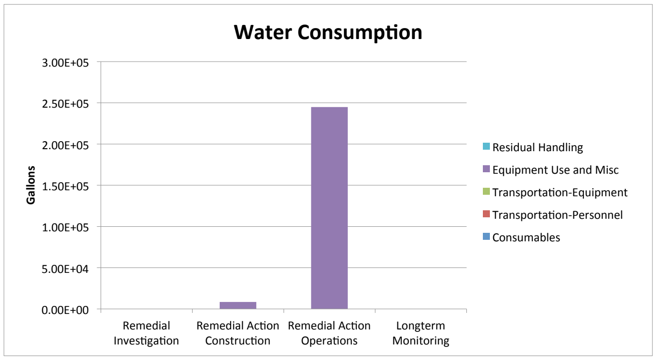


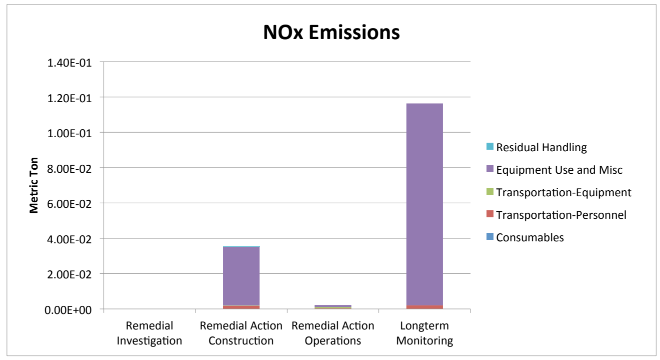


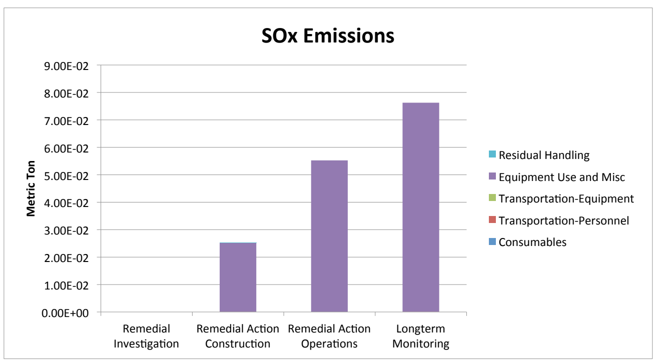


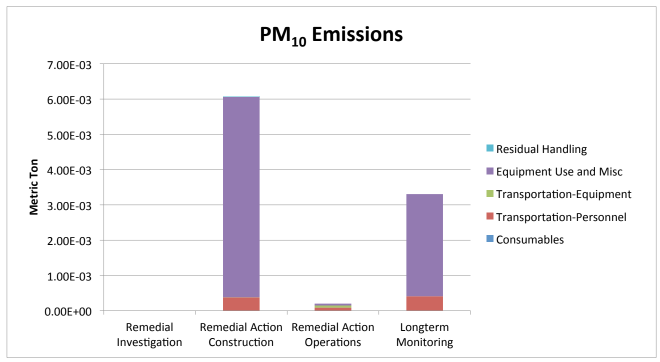

GHG Emissions
Metric Tons
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

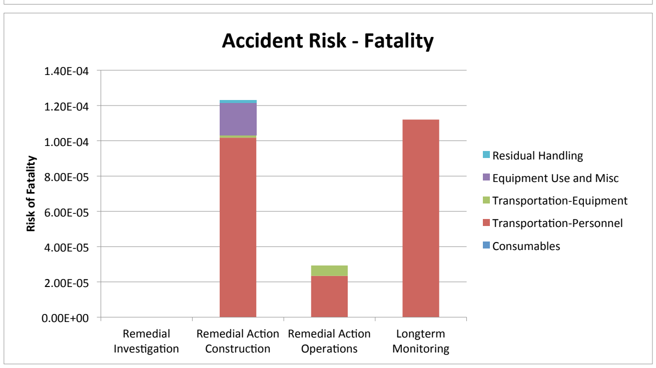

Total Energy Used
MMBTU
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

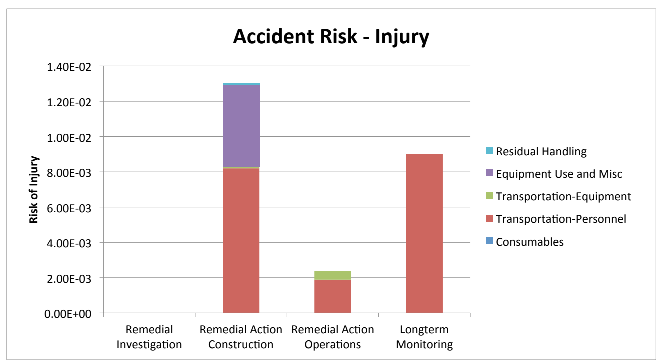

Water Consumption
Gallons
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

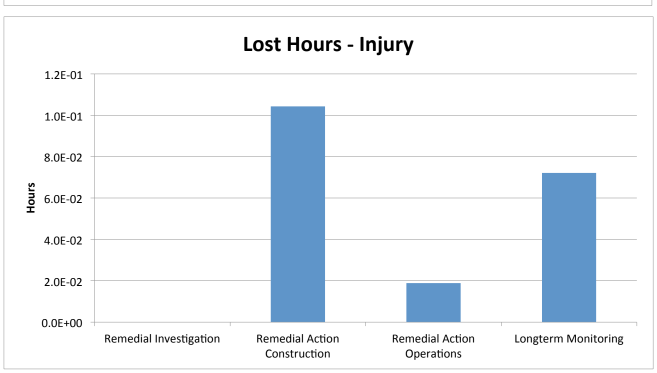

NOx Emissions
Metric Ton
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


SOx Emissions
Metric Ton
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


PM10 Emissions
Metric Ton
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


Accident Risk - Fatality
Risk of Fatality
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


Accident Risk - Injury
Risk of Injury
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring


Lost Hours - Injury
Hours
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

GSRx Results Alternative 3
Building 82, NAS South Weymouth
Weymouthg, Massachusetts

						Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	Technology Module / Phase	**Module Components**	**Comments / Assumptions**	**Quantity**	**(Units)**	**$CO_{2\ equiv}$**	**CO_2**	**N_20**	**CH_4**	**NO_x**	**SO_x**	**PM_{10}**		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection Well Instalation	PVC	420 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	420.00	lft	0.68	0.34	0.00	0.00	0.00	0.00	0.00	12.50	0.72
RAC	Injection Well Instalation	PVC	2660 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	2,660.00	lft	4.32	2.17	0.01	0.03	0.00	0.01	0.00	79.19	4.57
RAC	Temporary Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Temporary Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 5 units	125.00	lbs	0.28	0.14	0.00	0.00	0.00	0.00	0.00	5.17	0.21
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 16 units	400.00	lbs	0.90	0.45	0.00	0.01	0.00	0.00	0.00	16.54	0.69
RAO	EOS Reagent	Vegetable Oil	Asssume vegetable Oil, 615 gallons, density 10.939 ppg	6,727.49	lbs	1.01	1.01	0.00	0.00	0.00	0.00	0.00	35.03	3.04
RAO	EOS Reagent	Vegetable Oil	Asssume vegetable oil, 4,335 gallons, density 10.939 ppg	47,420.57	lbs	7.10	7.10	0.00	0.00	0.00	0.01	0.00	246.90	21.42
RAO	ORC Reagent	Lime	Assume limestone	150.00	lbs	0.07	0.06	0.00	0.00	0.00	0.00	0.00	0.58	0.00
RAO	EOS Reagent	Vegetable Oil	Asssume vegetable Oil, density 10.939 ppg, 4510 gallons per year, for year 5, 10, 15, 20, 25 and 30	296,009.34	lbs	44.30	44.30	0.00	0.00	0.00	0.04	0.00	1541.22	133.71
	Subtotal					**60.22**	**56.40**	**0.01**	**0.04**	**0.00**	**0.07**	**0.00**	**1946.30**	**164.63**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 12 wells, 8 hours per daoy, 80% utilization	15.36	hrs	0.25	0.24	0.00	0.00	0.00	0.00	0.00	1.88	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 12 wells,	12.00	hrs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.06	
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 76 wells, 8 hours per daoy, 80% utilization	97.28	hrs	1.56	1.52	0.00	0.00	0.02	0.00	0.00	11.89	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 76 wells,	76.00	hrs	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.36	
	Subtotal					**1.97**	**1.93**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**14.19**	**0**
				Total		**62**	**58**	**0.01**	**0.04**	**0.02**	**0.07**	**0.01**	**1,960**	**165**

Alternative 1
Values Input into SiteWise as "Other"

Module	**Greenhouse Gas Emissions**				**Criteria Pollutant Emission**			**Energy Consumption**	**Water Consumption**
	$CO_{2\ equiv}$	**CO_2**	**N_20 (CO2e)**	**CH_4 (CO2e)**	**NO_x**	**SO_x**	**PM_{10}**		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	9.72	5.87	2.92	0.93	0.02	0.02	0.01	466.61	6,453.27
RAO	52.47	52.46	0.01	0.00	0.00	0.05	0.00	6,222.57	158,172.21
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

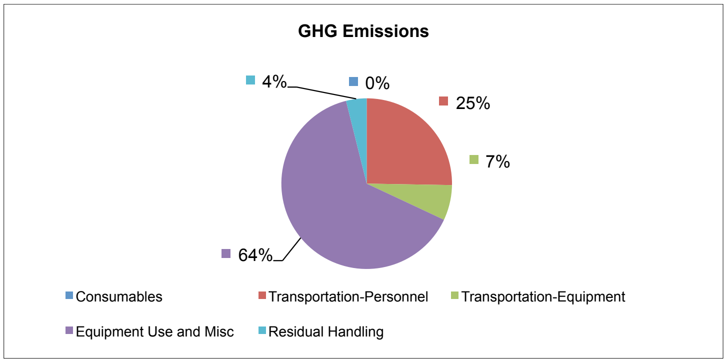
Sustainable Remediation - Environmental Footprint Summary
G-4

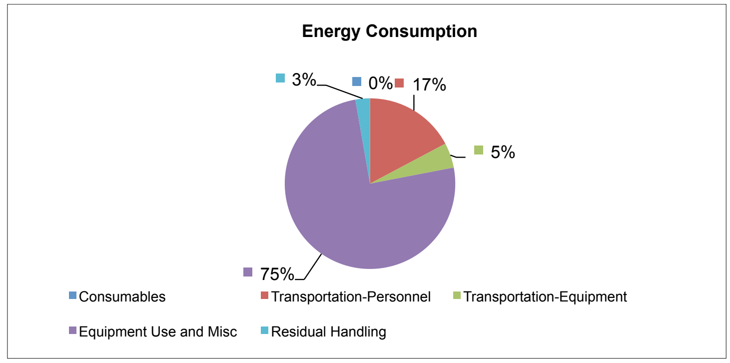
Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.91	1.2E+01	NA	3.4E-04	1.2E-05	6.9E-05	1.9E-05	1.5E-03
	Transportation-Equipment	0.24	3.2E+00	NA	7.6E-05	1.3E-06	6.8E-06	1.2E-06	9.4E-05
	Equipment Use and Misc	2.32	5.0E+01	3.0E+02	7.8E-03	5.0E-03	4.6E-04	1.3E-06	3.2E-04
	Residual Handling	0.14	1.8E+00	NA	4.4E-05	7.8E-07	3.9E-06	7.8E-07	6.3E-05
	Sub-Total	3.62	6.67E+01	3.01E+02	8.31E-03	4.98E-03	5.39E-04	2.20E-05	1.99E-03
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.47	6.9E+01	NA	2.0E-03	7.1E-05	4.1E-04	1.1E-04	9.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	33.02	4.9E+02	0.0E+00	1.1E-01	7.6E-02	2.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	38.49	5.62E+02	0.00E+00	1.16E-01	7.63E-02	3.31E-03	1.12E-04	9.02E-03
Total		**4.2E+01**	**6.3E+02**	**3.0E+02**	**1.2E-01**	**8.1E-02**	**3.8E-03**	**1.3E-04**	**1.1E-02**

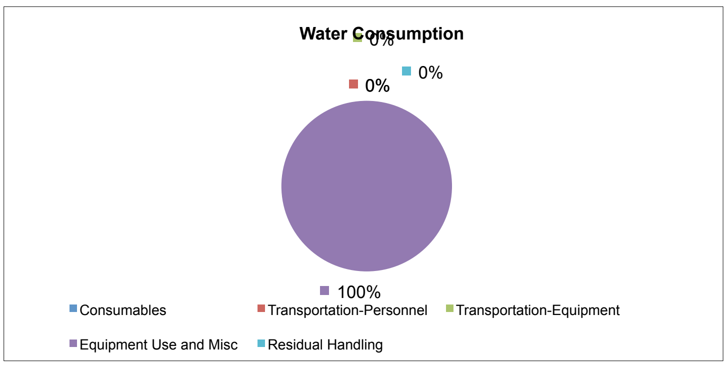
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space tons	Hazardous Waste Landfill Space tons	Topsoil Consumption cubic yards	Costing $	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.6E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	7.2E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**8.8E-02**

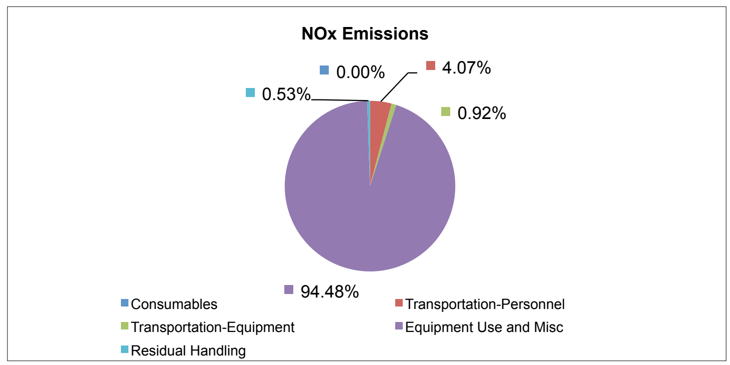
Total Cost with Footprint Reduction
$0

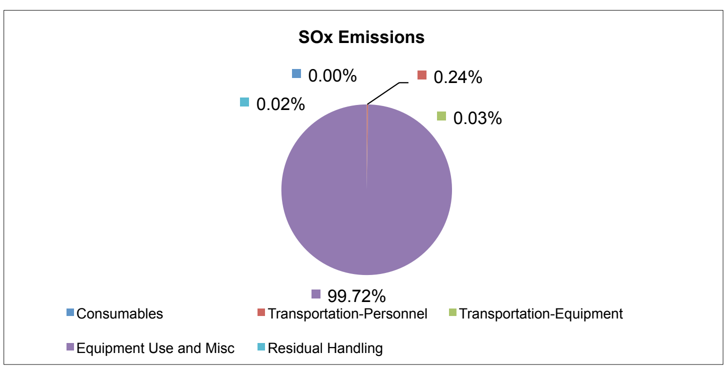
SiteWise™ Results Alternative G-4
Remedial Action Constructoin Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

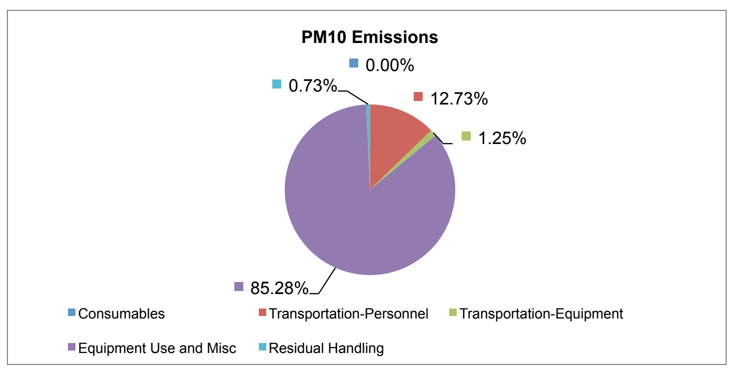


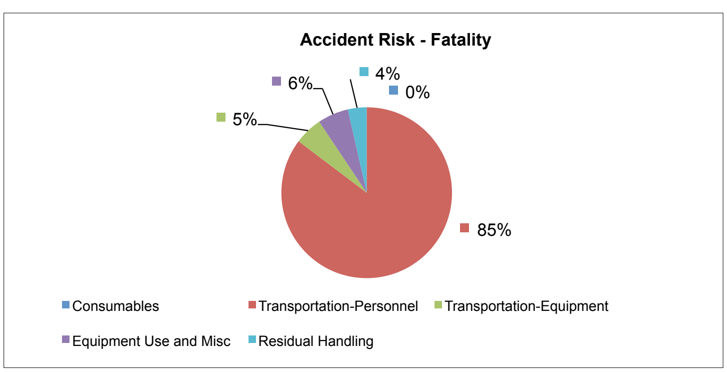


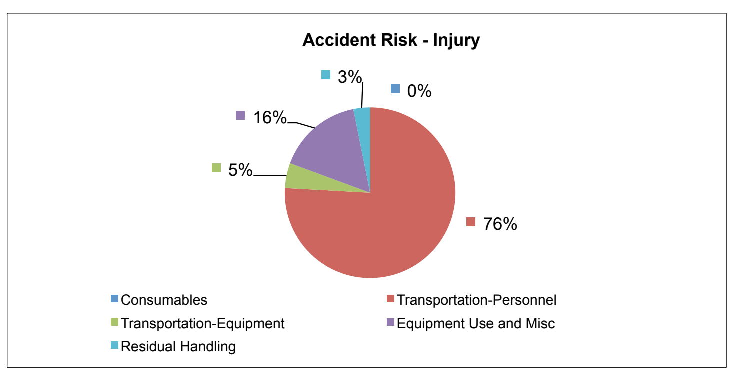




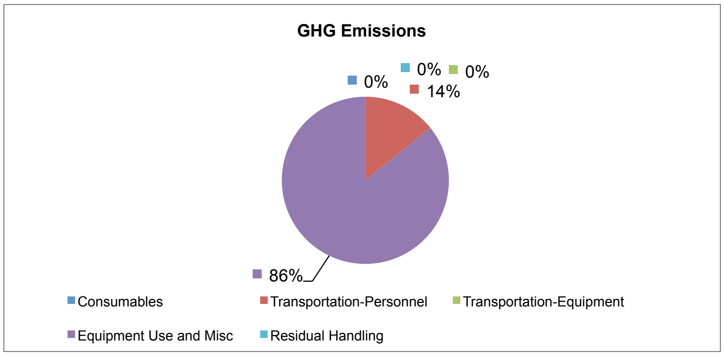


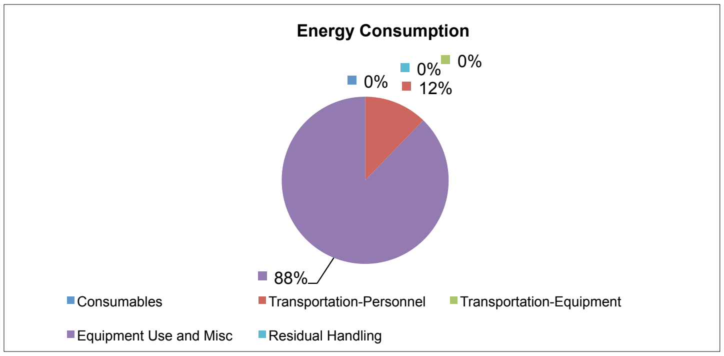


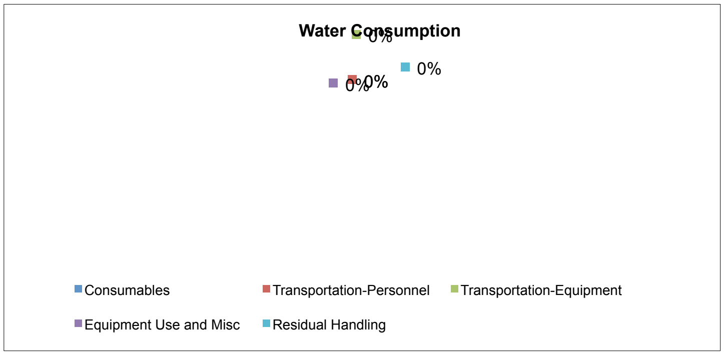


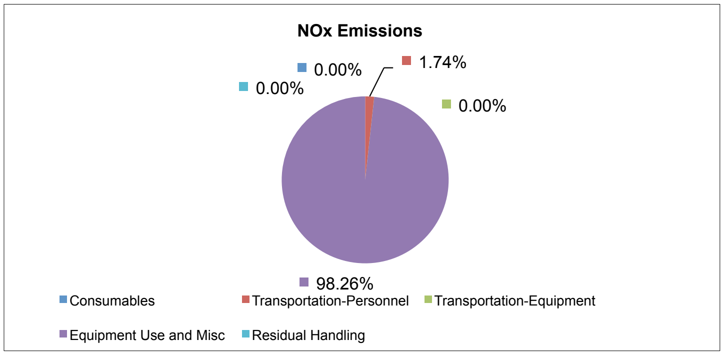


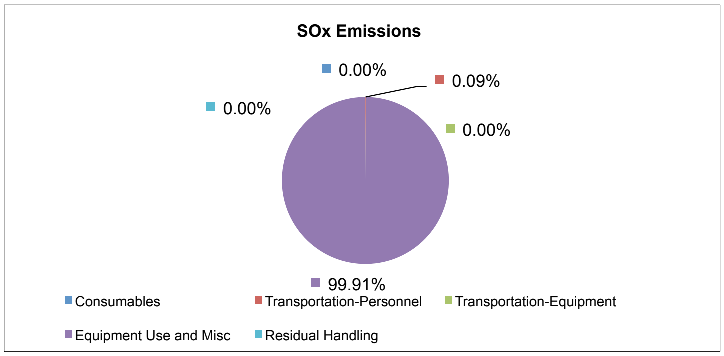
SiteWise™ Results Alternative G-4
Long Term Monitoring Stage
Building 82, NAS South Weymouth
Weymouth, Massachusetts

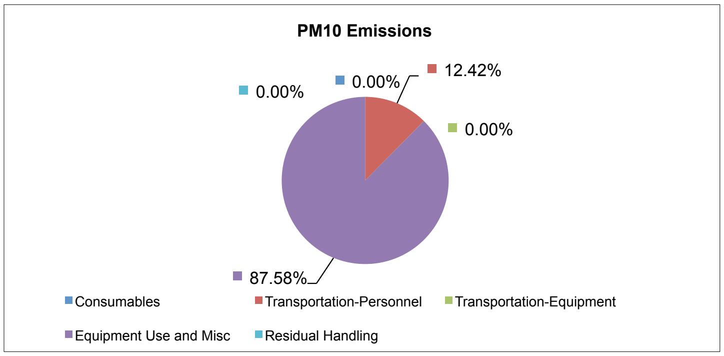


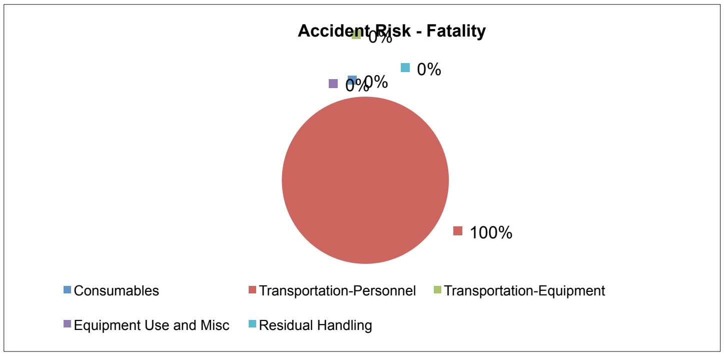


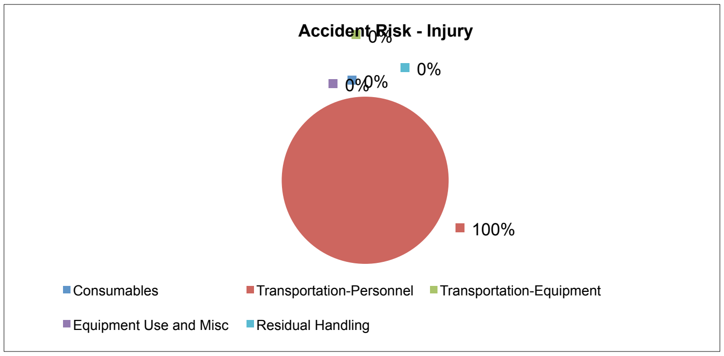


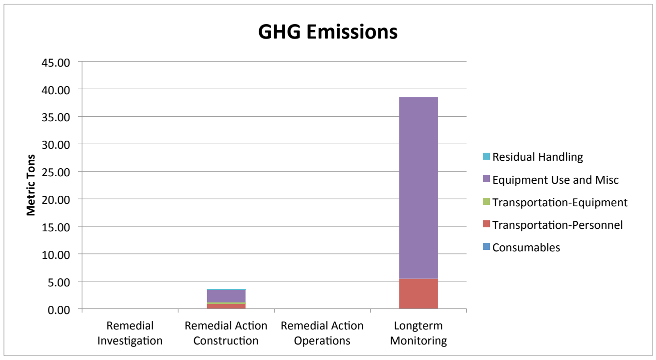


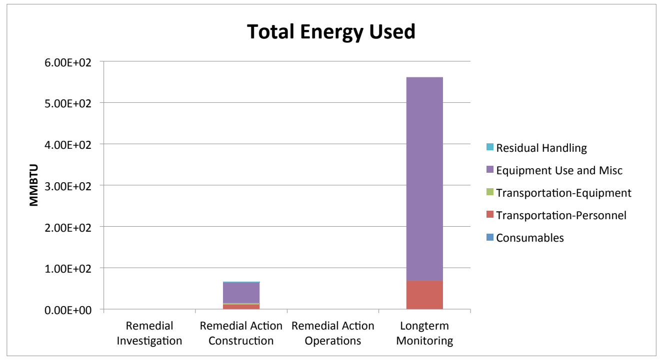


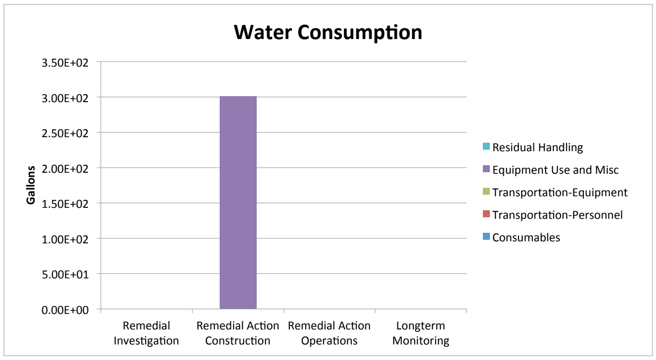


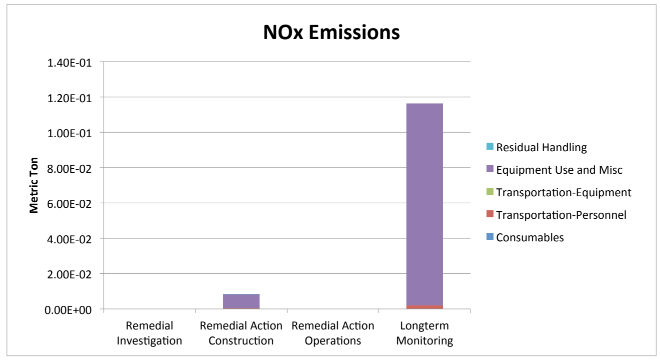


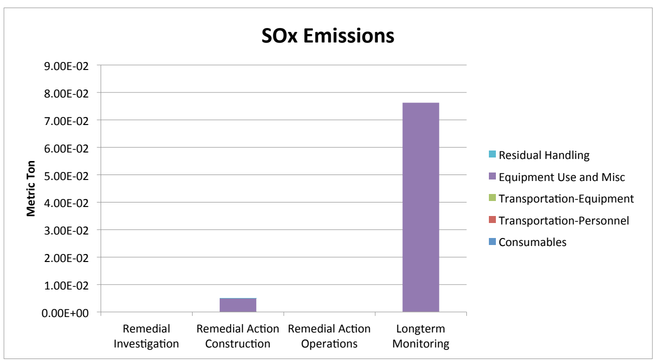


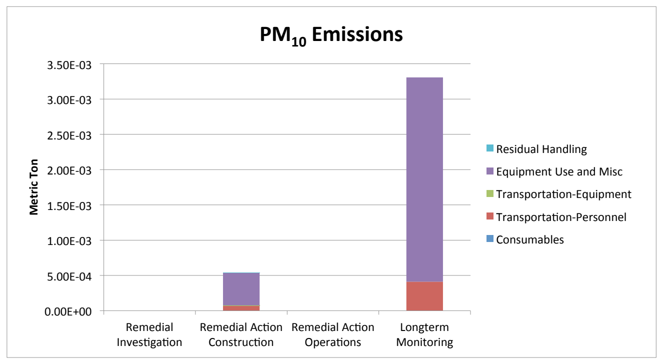

GHG Emissions
Metric Tons
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

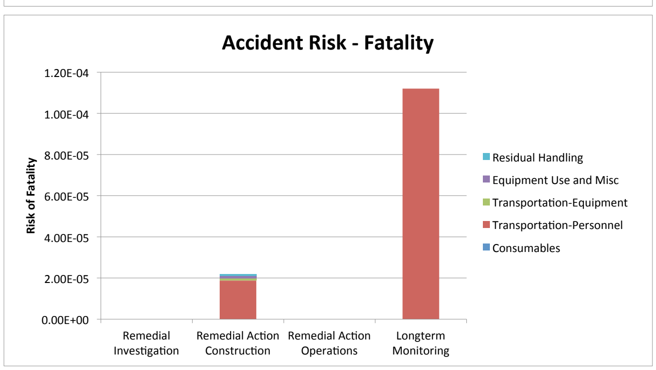

Total Energy Used
MMBTU
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

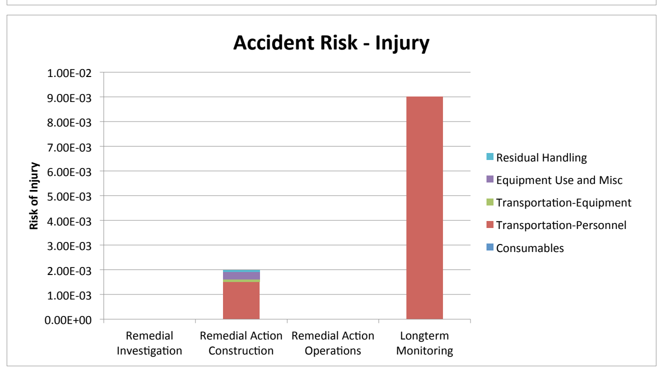

Water Consumption
Gallons
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

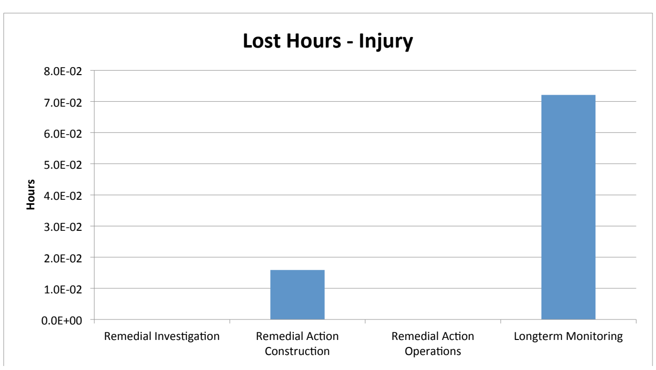

NOx Emissions
Metric Ton
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM_{10} Emissions
Metric Ton
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Lost Hours - Injury
Hours
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection Well Instalation	PVC	150 lf, Assume PVC, 2 in diameter, Schedule 40, 0.72 lb/ft	150	lft	0.24	0.12	0.00	0.00	0.00	0.00	0.00	4.47	0.26
RAC	Injection well heads	PVC	Assume PVC, 25 lb per unit, Assume 1 units	25	lbs	0.06	0.03	0.00	0.00	0.00	0.00	0.00	1.03	0.04
	Subtotal					**0.30**	**0.15**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**5.50**	**0.30**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 6 wells, 8 hours per daoy, 80% utilization	7.68	hrs	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.94	
RAC	Pavement Coring, Auger	Power Auger, 2 stroke, 1<HP<= 3, gas	1 hour per well, 6 wells,	6	hrs	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03	
	Subtotal					**0.13**	**0.13**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.97**	**0**
				Total		**0**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6**	**0**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	0.43	0.28	0.11	0.04	0.00	0.00	0.00	22.06	300.90
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

APPENDIX F

COST ESTIMATES

Cost Estimate - Alternative G-1

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-1:No Action
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare 5-Year Review Plan	100	hr			$37.00		$0	$0	$3,700	$0	$3,700
Subtotal							$0	$0	$3,700	$0	$3,700
Overhead on Labor Cost @ 30%									$1,110		$1,110
G & A on Cost @ 10%							$0	$0	$370	$0	$370
Tax on Materials and Equipment Cost @ 6%								$0		$0	$0
Total Direct Cost							$0	$0	$5,180	$0	$5,180
Indirects on Total Direct Cost @ 25%											$1,295
Profit on Total Direct Cost @ 10%											$518
Total Field Cost											$6,993
Contingency on Total Field Costs @ 15%											$1,049
Engineering on Total Field Costs @ 0%											$0
TOTAL CAPITAL COST											**$8,042**

Item	Item Cost year 1	Item Cost years 2 & 3	Item Cost years 4 - 15	Item Cost every 5 years	Notes
Site Review				$23,000	Five year review reports
Subtotal	$0	$0	$0	$23,000	
Contingency @ 10%	$0	$0	$0	$2,300	
TOTAL	**$0**	**$0**	**$0**	**$25,300**	

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-1:No Action
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$8,042		$8,042	1.000	$8,042
1		$0	$0	0.980	$0
2		$0	$0	0.961	$0
3		$0	$0	0.942	$0
4		$0	$0	0.924	$0
5		$25,300	$25,300	0.906	$22,915
6		$0	$0	0.888	$0
7		$0	$0	0.871	$0
8		$0	$0	0.853	$0
9		$0	$0	0.837	$0
10		$25,300	$25,300	0.820	$20,755
11		$0	$0	0.804	$0
12		$0	$0	0.788	$0
13		$0	$0	0.773	$0
14		$0	$0	0.758	$0
15		$25,300	$25,300	0.743	$18,798
16		$0	$0	0.728	$0
17		$0	$0	0.714	$0
18		$0	$0	0.700	$0
19		$0	$0	0.686	$0
20		$25,300	$25,300	0.673	$17,026
21		$0	$0	0.660	$0
22		$0	$0	0.647	$0
23		$0	$0	0.634	$0
24		$0	$0	0.622	$0
25		$25,300	$25,300	0.610	$15,421
26		$0	$0	0.598	$0
27		$0	$0	0.586	$0
28		$0	$0	0.574	$0
29		$0	$0	0.563	$0
30		$25,300	$25,300	0.552	$13,967

TOTAL PRESENT WORTH **$116,925**

Cost Estimate - Alternative G-2

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2: In-Situ Chemical Oxidation, MNA, LUCs
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 ISCO Design	1	ls	$4,000.00				$4,000	$0	$0	$0	$4,000
1.2 Prepare Documents & Plans	500	hr			$60.00		$0	$0	$30,000	$0	$30,000
1.3 Prepare LTM Plan	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
1.4 Prepare LUC Documents	150	hr			$60.00		$0	$0	$9,000	$0	$9,000
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	2	ea			$170.00	$522.00	$0	$0	$340	$1,044	$1,384
2.3 Mobilization/Demobilization DPT Sub	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
2.4 Mobilization/Demobilization HSA Sub	2	ea	$1,000.00				$2,000	$0	$0	$0	$2,000
2.5 Mobilization/Demobilization ISCO Sub	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
3 SITE SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	3	mo		$220.00	$370.00		$0	$660	$1,110	$0	$1,770
3.2 Equipment Decon Pad	1	ls		$1,850.00	$1,000.00	$300.00	$0	$1,850	$1,000	$300	$3,150
3.3 Underground Utility Clearances	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
3.4 Construction Survey Support	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3.5 Site Superintendent	60	day		$167.00	$384.64		$0	$10,020	$23,078	$0	$33,098
3.6 Site Health & Safety/QC	20	day		$167.00	$356.25		$0	$3,340	$7,125	$0	$10,465
3.7 Site Labor, 2 each	40	day			$361.60		$0	$0	$14,464	$0	$14,464
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,247.00	$1,551.00	$0	$2,440	$4,494	$3,102	$10,036
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$730.00	$0	$0	$0	$1,460	$1,460
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$660.00	$0	$0	$0	$1,320	$1,320
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$950.00				$1,900	$0	$0	$0	$1,900
5 BENCH TEST											
5.1 Bench Test Sampling	40	hr			$37.50		$0	$0	$1,500	$0	$1,500
5.2 Bench Test Sampling ODC	1	ls		$500.00			$0	$500	$0	$0	$500
5.3 Bench Test Analysis	5	ea	$200.00				$1,000	$0	$0	$0	$1,000
6 PILOT STUDY											
6.1 Work Plan	1	ls			$15,000.00		$0	$0	$15,000	$0	$15,000
-Injections											
6.2 Injection Well Installation	420	lf	$40.00				$16,800	$0	$0	$0	$16,800
6.3 Injection Well Heads	12	ea	$150.00				$1,800	$0	$0	$0	$1,800
6.4 Injection Labor/Equipment	2	day	$4,000.00				$8,000	$0	$0	$0	$8,000
6.5 ISCO Reagent	21,000	gal		$0.86			$0	$17,955	$0	$0	$17,955
6.6 ISCO Injection Water	17,000	gal		$0.20			$0	$3,400	$0	$0	$3,400
6.7 Water Tank Truck	2	day				$430.00	$0	$0	$0	$860	$860
6.8 IDW Disposal	24	drum	$200.00				$4,800	$0	$0	$0	$4,800
6.9 Pavement Coring & Repair	12	ea	$85.00				$1,020	$0	$0	$0	$1,020
-Post-Injection Sampling											
6.10 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
6.11 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
6.12 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
6.13 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2: In-Situ Chemical Oxidation, MNA, LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7 FULL TREATMENT											
-Injections											
7.1 DPT Injection	4	day	$2,500.00				$10,000	$0	$0	$0	$10,000
7.2 Injection Well Installation	3,780	lf	$40.00				$151,200	$0	$0	$0	$151,200
7.3 Injection Well Heads	108	ea	$150.00				$16,200	$0	$0	$0	$16,200
7.4 Injection Labor/Equipment	10	day	$4,000.00				$40,000	$0	$0	$0	$40,000
7.5 ISCO Reagent	189,400	gal		$0.86			$0	$161,937	$0	$0	$161,937
7.6 ISCO Makeup Water	149,000	gal		$0.20			$0	$29,800	$0	$0	$29,800
7.7 Water Tank Truck	10	day				$430.00	$0	$0	$0	$4,300	$4,300
7.8 IDW Disposal	216	drum	$200.00				$43,200	$0	$0	$0	$43,200
7.9 Pavement Coring & Repair	108	ea	$85.00				$9,180	$0	$0	$0	$9,180
-Post-Injection Sampling											
7.10 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
7.11 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
7.12 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
7.13 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
8 NA BASELINE SAMPLING (2 events)											
8.1 NA Sampling Labor	320	hr			$37.50		$0	$0	$12,000	$0	$12,000
8.2 NA Sampling ODC	2	ea		$2,000.00			$0	$4,000	$0	$0	$4,000
8.3 NA Sampling Analysis	2	ea	$4,000.00				$8,000	$0	$0	$0	$8,000
8.4 NA Sampling Report	320	hr			$37.50		$0	$0	$12,000	$0	$12,000
9 POST-CONSTRUCTION											
9.1 Contractor Completion Report	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
9.2 Remedial Action Close-out Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
Subtotal							$359,100	$243,802	$232,861	$16,186	$851,949
Overhead on Labor Cost @ 30%									$69,858		$69,858
G & A on Cost @ 10%							$35,910	$24,380	$23,286	$1,619	$85,195
Tax on Materials and Equipment Cost @ 6%								$14,628		$971	$15,599
Total Direct Cost							$395,010	$282,810	$326,006	$18,776	$1,022,602
Indirects on Total Direct Cost @ 25%											$255,651
Profit on Total Direct Cost @ 10%											$102,260
Total Field Cost											$1,380,513
Contingency on Total Field Costs @ 15%											$207,077
Engineering on Total Field Costs @ 2%											$27,610
TOTAL CAPITAL COST											**$1,615,200**

Item	Item Cost year 1	Item Cost years 2 & 3	Item Cost years 4 - 30	Item Cost every 5 years	Notes
Site Inspection: Visit & Report	$4,570	$4,570	$4,570		One-day visit to verify LUC & report.
Sample Collection	$54,800	$27,400	$13,700		Labor and supplies for groundwater samples using a crew of two, four times a year in year 1, twice a year in years 2 & 3, and once a year in years 4 through 30.
Analysis; Water	$16,000	$8,000	$4,000		Analyze groundwater samples for TCE, 1,1-DCA, n-nitroso-di-n-propylamine, MTBE, PCBs, Mn, and MNA parameters
Report	$48,000	$24,000	$12,000		
Site Review				$23,000	Five year review reports
Subtotal	$123,370	$63,970	$34,270	$23,000	
Contingency @ 10%	$12,337	$6,397	$3,427	$2,300	
TOTAL	**$135,707**	**$70,367**	**$37,697**	**$25,300**	

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2: In-Situ Chemical Oxidation, MNA, LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$1,615,200		$1,615,200	1.000	$1,615,200
1		$135,707	$135,707	0.980	$133,046
2		$70,367	$70,367	0.961	$67,635
3		$70,367	$70,367	0.942	$66,308
4		$37,697	$37,697	0.924	$34,826
5		$62,997	$62,997	0.906	$57,058
6		$37,697	$37,697	0.888	$33,474
7		$37,697	$37,697	0.871	$32,818
8		$37,697	$37,697	0.853	$32,174
9		$37,697	$37,697	0.837	$31,543
10		$62,997	$62,997	0.820	$51,679
11		$37,697	$37,697	0.804	$30,318
12		$37,697	$37,697	0.788	$29,724
13		$37,697	$37,697	0.773	$29,141
14		$37,697	$37,697	0.758	$28,570
15		$62,997	$62,997	0.743	$46,808
16		$37,697	$37,697	0.728	$27,460
17		$37,697	$37,697	0.714	$26,922
18		$37,697	$37,697	0.700	$26,394
19		$37,697	$37,697	0.686	$25,876
20		$62,997	$62,997	0.673	$42,395
21		$37,697	$37,697	0.660	$24,872
22		$37,697	$37,697	0.647	$24,384
23		$37,697	$37,697	0.634	$23,906
24		$37,697	$37,697	0.622	$23,437
25		$62,997	$62,997	0.610	$38,399
26		$37,697	$37,697	0.598	$22,527
27		$37,697	$37,697	0.586	$22,085
28		$37,697	$37,697	0.574	$21,652
29		$37,697	$37,697	0.563	$21,228
30		$62,997	$62,997	0.552	$34,779

TOTAL PRESENT WORTH **$2,726,637**

Cost Estimate - Alternative G-2A

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2A: Full Plume In-Situ Chemical Oxidation, Monitoring, LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING & DOCUMENTS											
1.1 ISCO Design	1	ls	$4,000.00				$4,000	$0	$0	$0	$4,000
1.2 Prepare Documents & Plans	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
1.3 Prepare LTM Plan	500	hr			$60.00		$0	$0	$30,000	$0	$30,000
1.4 Prepare LUC Documents	150	hr			$60.00		$0	$0	$9,000	$0	$9,000
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	2	ea			$170.00	$522.00	$0	$0	$340	$1,044	$1,384
2.3 Mobilization/Demobilization DPT Sub	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
2.4 Mobilization/Demobilization HSA Sub	2	ea	$1,000.00				$2,000	$0	$0	$0	$2,000
2.5 Mobilization/Demobilization ISCO Sub	2	ls	$15,000.00				$30,000	$0	$0	$0	$30,000
3 SITE SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	6	mo		$220.00	$370.00		$0	$1,320	$2,220	$0	$3,540
3.2 Equipment Decon Pad	1	ls		$1,850.00	$1,000.00	$300.00	$0	$1,850	$1,000	$300	$3,150
3.3 Underground Utility Clearances	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
3.4 Construction Survey Support	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3.5 Site Superintendent	80	day		$167.00	$384.64		$0	$13,360	$30,771	$0	$44,131
3.6 Site Health & Safety/QC	30	day		$167.00	$356.25		$0	$5,010	$10,688	$0	$15,698
3.7 Site Labor, 2 each	50	day			$361.60		$0	$0	$18,080	$0	$18,080
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,247.00	$1,551.00	$0	$2,440	$4,494	$3,102	$10,036
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	3,000	gal		$0.20			$0	$600	$0	$0	$600
4.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$730.00	$0	$0	$0	$2,190	$2,190
4.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$660.00	$0	$0	$0	$1,980	$1,980
4.6 Disposal of Decon Waste (liquid & solid)	3	mo	$950.00				$2,850	$0	$0	$0	$2,850
5 BENCH TEST								$0	$0	$0	
5.1 Bench Test Sampling	40	hr			$37.50		$0	$0	$1,500	$0	$1,500
5.2 Bench Test Sampling ODC	1	ls		$500.00			$0	$500	$0	$0	$500
5.3 Bench Test Analysis	5	ea	$200.00				$1,000	$0	$0	$0	$1,000
6 PILOT STUDY (actually a phased approach will be used. Keep this for estimating purposes.)											
6.1 Work Plan	1	ls			$15,000.00		$0	$0	$15,000	$0	$15,000
-Injections											
6.2 Injection Well Installation	420	lf	$40.00				$16,800	$0	$0	$0	$16,800
6.3 Injection Well Heads	12	ea	$150.00				$1,800	$0	$0	$0	$1,800
6.4 Injection Labor/Equipment	2	day	$4,000.00				$8,000	$0	$0	$0	$8,000
6.5 ISCO Reagent	21,000	gal		$0.86			$0	$17,955	$0	$0	$17,955
6.6 ISCO Injection Water	17,000	gal		$0.20			$0	$3,400	$0	$0	$3,400
6.7 Water Tank Truck	2	day				$430.00	$0	$0	$0	$860	$860
6.8 IDW Disposal	24	drum	$200.00				$4,800	$0	$0	$0	$4,800
6.9 Pavement Coring & Repair	12	ea	$85.00				$1,020	$0	$0	$0	$1,020
-Post-Injection Sampling											
6.10 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
6.11 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
6.12 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
6.13 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2A: Full Plume In-Situ Chemical Oxidation, Monitoring, LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7 FULL TREATMENT											
-Injections											
7.1 DPT Injection	4	day	$2,500.00				$10,000	$0	$0	$0	$10,000
7.2 Injection Well Installation	6,860	lf	$40.00				$274,400	$0	$0	$0	$274,400
7.3 Injection Well Heads	196	ea	$150.00				$29,400	$0	$0	$0	$29,400
7.4 Injection Labor/Equipment	14	day	$4,000.00				$56,000	$0	$0	$0	$56,000
7.5 ISCO Reagent	362,000	gal		$0.86			$0	$309,510	$0	$0	$309,510
7.6 ISCO Makeup Water	286,000	gal		$0.20			$0	$57,200	$0	$0	$57,200
7.7 Water Tank Truck	14	day				$430.00	$0	$0	$0	$6,020	$6,020
7.8 IDW Disposal	184	drum	$200.00				$36,800	$0	$0	$0	$36,800
7.9 Pavement Coring & Repair	152	ea	$85.00				$12,920	$0	$0	$0	$12,920
-Post-Injection Sampling											
7.10 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
7.11 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
7.12 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
7.13 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
8 PERFORMANCE SAMPLING (12 events)											
8.1 Sampling Labor	480	hr			$37.50		$0	$0	$18,000	$0	$18,000
8.2 Sampling ODC	12	ea		$2,000.00			$0	$24,000	$0	$0	$24,000
8.3 Sampling Analysis	12	ea	$600.00				$7,200	$0	$0	$0	$7,200
8.4 Sampling Report	1,200	hr			$37.50		$0	$0	$45,000	$0	$45,000
9 POST-CONSTRUCTION											
9.1 Contractor Completion Report	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
9.2 Remedial Action Close-out Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
Subtotal							$523,990	$444,645	$287,843	$19,296	$1,275,774
Overhead on Labor Cost @ 30%									$86,353		$86,353
G & A on Cost @ 10%							$52,399	$44,465	$28,784	$1,930	$127,577
Tax on Materials and Equipment Cost @ 6%								$26,679		$1,158	$27,836
Total Direct Cost							$576,389	$515,788	$402,980	$22,383	$1,517,540
Indirects on Total Direct Cost @ 25%											$379,385
Profit on Total Direct Cost @ 10%											$151,754
Total Field Cost											$2,048,679
Contingency on Total Field Costs @ 15%											$307,302
Engineering on Total Field Costs @ 2%											$40,974
TOTAL CAPITAL COST											**$2,396,955**

Item	Item Cost year 1	Item Cost years 2 & 3	Item Cost years 4 - 30	Item Cost every 5 years	Notes
Site Inspection: Visit & Report	$4,570	$4,570	$4,570		One-day visit to verify LUC & report.
Sample Collection	$37,600	$18,800	$9,400		Labor and supplies for groundwater samples using a crew of two, four times a year in year 1, twice a year in years 2 & 3, and once a year in years 4 through 30.
Analysis; Water	$1,600	$800	$400		Analyze groundwater samples for MTBE (1 well), PCBs (1 well), and Mn (6 wells)
Report	$48,000	$24,000	$12,000		
Site Review				$23,000	Five year review reports
Subtotal	$91,770	$48,170	$26,370	$23,000	
Contingency @ 10%	$9,177	$4,817	$2,637	$2,300	
TOTAL	**$100,947**	**$52,987**	**$29,007**	**$25,300**	

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-2A: Full Plume In-Situ Chemical Oxidation, Monitoring, LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$2,396,955		$2,396,955	1.000	$2,396,955
1		$100,947	$100,947	0.980	$98,968
2		$52,987	$52,987	0.961	$50,929
3		$52,987	$52,987	0.942	$49,931
4		$29,007	$29,007	0.924	$26,798
5		$54,307	$54,307	0.906	$49,188
6		$29,007	$29,007	0.888	$25,757
7		$29,007	$29,007	0.871	$25,252
8		$29,007	$29,007	0.853	$24,757
9		$29,007	$29,007	0.837	$24,272
10		$54,307	$54,307	0.820	$44,551
11		$29,007	$29,007	0.804	$23,329
12		$29,007	$29,007	0.788	$22,872
13		$29,007	$29,007	0.773	$22,423
14		$29,007	$29,007	0.758	$21,984
15		$54,307	$54,307	0.743	$40,351
16		$29,007	$29,007	0.728	$21,130
17		$29,007	$29,007	0.714	$20,716
18		$29,007	$29,007	0.700	$20,310
19		$29,007	$29,007	0.686	$19,911
20		$54,307	$54,307	0.673	$36,547
21		$29,007	$29,007	0.660	$19,138
22		$29,007	$29,007	0.647	$18,763
23		$29,007	$29,007	0.634	$18,395
24		$29,007	$29,007	0.622	$18,034
25		$54,307	$54,307	0.610	$33,102
26		$29,007	$29,007	0.598	$17,334
27		$29,007	$29,007	0.586	$16,994
28		$29,007	$29,007	0.574	$16,661
29		$29,007	$29,007	0.563	$16,334
30		$54,307	$54,307	0.552	$29,981

TOTAL PRESENT WORTH **$3,271,667**

Cost Estimate - Alternative G-3

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-3: Enhanced Bioremediation, MNA, LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 EOS, ORC, and ISCO Design	1	ls	$8,000.00				$8,000	$0	$0	$0	$8,000
1.2 Prepare Documents & Plans	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
1.3 Prepare LTM Plan	500	hr			$60.00		$0	$0	$30,000	$0	$30,000
1.4 Prepare LUC Documents	150	hr			$60.00		$0	$0	$9,000	$0	$9,000
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	2	ea			$170.00	$522.00	$0	$0	$340	$1,044	$1,384
2.3 Mobilization/Demobilization DPT Sub	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
2.4 Mobilization/Demobilization HSA Sub	2	ea	$1,000.00				$2,000	$0	$0	$0	$2,000
2.5 Mobilization/Demobilization ORC Sub	1	ea	$1,000.00				$1,000	$0	$0	$0	$1,000
3 SITE SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	3	mo		$220.00	$370.00		$0	$660	$1,110	$0	$1,770
3.2 Equipment Decon Pad	1	ls		$1,850.00	$1,000.00	$300.00	$0	$1,850	$1,000	$300	$3,150
3.3 Underground Utility Clearances	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
3.4 Construction Survey Support	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3.5 Site Superintendent	60	day		$167.00	$384.64		$0	$10,020	$23,078	$0	$33,098
3.6 Site Health & Safety/QC	20	day		$167.00	$356.25		$0	$3,340	$7,125	$0	$10,465
3.7 Site Labor, 2 each	40	day			$361.60		$0	$0	$14,464	$0	$14,464
4 DECONTAMINATION											
4.1 Decontamination Services	2	mo		$1,220.00	$2,247.00	$1,551.00	$0	$2,440	$4,494	$3,102	$10,036
4.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$300.00	$0	$1,500	$2,000	$300	$3,800
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$730.00	$0	$0	$0	$1,460	$1,460
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$660.00	$0	$0	$0	$1,320	$1,320
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$950.00				$1,900	$0	$0	$0	$1,900
5 BENCH TEST											
5.1 Bench Test Sampling	40	hr			$37.50		$0	$0	$1,500	$0	$1,500
5.2 Bench Test Sampling ODC	1	ls		$500.00			$0	$500	$0	$0	$500
5.3 Bench Test Analysis	8	ea	$200.00				$1,600	$0	$0	$0	$1,600
6 PILOT STUDY											
6.1 Work Plan	1	ls			$15,000.00		$0	$0	$15,000	$0	$15,000
-Injections											
6.2 Injection Well Installation	420	lf	$10.00				$4,200	$0	$0	$0	$4,200
6.3 Injection Well Heads	12	ea	$150.00				$1,800	$0	$0	$0	$1,800
6.4 Injection Labor/Equipment	2	day	$4,000.00				$8,000	$0	$0	$0	$8,000
6.5 EOS Reagent	615	gal		$26.00			$0	$15,990	$0	$0	$15,990
6.6 EOS Injection Water	5,535	gal		$0.20			$0	$1,107	$0	$0	$1,107
6.7 Water Tank Truck	2	day				$430.00	$0	$0	$0	$860	$860
6.8 IDW Disposal	24	drum	$200.00				$4,800	$0	$0	$0	$4,800
6.9 Pavement Coring & Repair	12	ea	$85.00				$1,020	$0	$0	$0	$1,020
-Post-Injection Sampling											
6.10 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
6.11 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
6.12 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
6.13 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-3: Enhanced Bioremediation, MNA, LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7 FULL TREATMENT											
-Injections											
7.1 EOS DPT Injection (shallow)	2	day	$2,500.00				$5,000	$0	$0	$0	$5,000
7.2 ORC DPT Injection (shallow)	1	day	$2,500.00				$2,500	$0	$0	$0	$2,500
7.3 EOS Injection Well Installation (deep)	2,660	lf	$10.00				$26,600	$0	$0	$0	$26,600
7.5 EOS Injection Well Heads	76	ea	$150.00				$11,400	$0	$0	$0	$11,400
7.7 Injection Labor/Equipment	7	day	$4,000.00				$28,000	$0	$0	$0	$28,000
7.8 EOS Reagent	4,335	gal		$26.00			$0	$112,710	$0	$0	$112,710
7.9 EOS Makeup Water	39,015	gal		$0.20			$0	$7,803	$0	$0	$7,803
7.10 ORC Reagent	150	lb		$8.95			$0	$1,343	$0	$0	$1,343
7.11 ORC Makeup Water	60	gal		$0.20			$0	$12	$0	$0	$12
7.14 Water Tank Truck	10	day				$430.00	$0	$0	$0	$4,300	$4,300
7.15 IDW Disposal	152	drum	$200.00				$30,400	$0	$0	$0	$30,400
7.16 Pavement Coring & Repair	76	ea	$85.00				$6,460	$0	$0	$0	$6,460
-Post-Injection Sampling											
7.17 Post-Injection Sampling Labor	250	hr			$37.50		$0	$0	$9,375	$0	$9,375
7.18 Post-Injection Sampling ODC	5	ea		$500.00			$0	$2,500	$0	$0	$2,500
7.19 Post-Injection Analysis	5	ea	$1,000.00				$5,000	$0	$0	$0	$5,000
7.20 Post-Injection Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
8 NA BASELINE SAMPLING (2 events)											
8.1 NA Sampling Labor	320	hr			$37.50		$0	$0	$12,000	$0	$12,000
8.2 NA Sampling ODC	2	ea		$2,000.00			$0	$4,000	$0	$0	$4,000
8.3 NA Sampling Analysis	2	ea	$4,000.00				$8,000	$0	$0	$0	$8,000
8.4 NA Sampling Report	320	hr			$37.50		$0	$0	$12,000	$0	$12,000
9 POST-CONSTRUCTION											
9.1 Contractor Completion Report	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
9.2 Remedial Action Close-out Report	250	hr			$60.00		$0	$0	$15,000	$0	$15,000
Subtotal							$177,680	$169,675	$232,861	$16,186	$596,402
Overhead on Labor Cost @ 30%									$69,858		$69,858
G & A on Cost @ 10%							$17,768	$16,967	$23,286	$1,619	$59,640
Tax on Materials and Equipment Cost @ 6%								$10,180		$971	$11,152
Total Direct Cost							$195,448	$196,822	$326,006	$18,776	$737,052
Indirects on Total Direct Cost @ 25%											$184,263
Profit on Total Direct Cost @ 10%											$73,705
Total Field Cost											$995,020
Contingency on Total Field Costs @ 15%											$149,253
Engineering on Total Field Costs @ 2%											$19,900
TOTAL CAPITAL COST											**$1,164,174**

	Item	Quantity	Unit	Unit Cost	Subtotal
	EOS REINJECTION IN DEEP TCE PLUME (EVERY 5 YEARS)				
	-Injections				
1	Injection Labor/Equipment	5	day	$4,000.00	$20,000
2	EOS Reagent	4,510	gal	$26.00	$117,260
3	EOS Makeup Water	40,590	gal	$0.20	$8,118
4	Water Tank Truck	5	day	$430.00	$2,150
6	Project Management	1	ls	$3,000	$3,000
7	Well Redelopment/Maintenance	80	each	$500	$40,000
8	Reports	1	ea	$10,000	$10,000
	Subtotal				$200,528 O&M per event

Item	Item Cost year 1	Item Cost years 2 & 3	Item Cost years 4 - 30	Item Cost every 5 years	Notes
Site Inspection: Visit & Report	$4,570	$4,570	$4,570		One-day visit to verify LUC & report.
Sample Collection	$54,800	$27,400	$13,700		Labor and supplies for groundwater samples using a crew of two, four times a year in year 1, twice a year in years 2 & 3, and once a year in years 4 through 30 and issue a report.
Analysis; Water	$16,000	$8,000	$4,000		Analyze groundwater samples for TCE, 1,1-DCA, n-nitroso-di-n-propylamine, MTBE, PCBs, Mn, and MNA parameters
Report	$48,000	$24,000	$12,000		
Site Review				$23,000	Five year review reports
Subtotal	$123,370	$63,970	$34,270	$23,000	
Contingency @ 10%	$12,337	$6,397	$3,427	$2,300	
TOTAL	**$135,707**	**$70,367**	**$37,697**	**$25,300**	

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-3: Enhanced Bioremediation, MNA, LUCs
Present Worth Analysis

Year	Capital Cost	Operation and Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$1,164,174			$1,164,174	1.000	$1,164,174
1			$135,707	$135,707	0.980	$133,046
2			$70,367	$70,367	0.961	$67,635
3			$70,367	$70,367	0.942	$66,308
4			$37,697	$37,697	0.924	$34,826
5		$200,528	$62,997	$263,525	0.906	$238,683
6			$37,697	$37,697	0.888	$33,474
7			$37,697	$37,697	0.871	$32,818
8			$37,697	$37,697	0.853	$32,174
9			$37,697	$37,697	0.837	$31,543
10		$200,528	$62,997	$263,525	0.820	$216,182
11			$37,697	$37,697	0.804	$30,318
12			$37,697	$37,697	0.788	$29,724
13			$37,697	$37,697	0.773	$29,141
14			$37,697	$37,697	0.758	$28,570
15		$200,528	$62,997	$263,525	0.743	$195,803
16			$37,697	$37,697	0.728	$27,460
17			$37,697	$37,697	0.714	$26,922
18			$37,697	$37,697	0.700	$26,394
19			$37,697	$37,697	0.686	$25,876
20			$62,997	$62,997	0.673	$42,395
21			$37,697	$37,697	0.660	$24,872
22			$37,697	$37,697	0.647	$24,384
23			$37,697	$37,697	0.634	$23,906
24			$37,697	$37,697	0.622	$23,437
25			$62,997	$62,997	0.610	$38,399
26			$37,697	$37,697	0.598	$22,527
27			$37,697	$37,697	0.586	$22,085
28			$37,697	$37,697	0.574	$21,652
29			$37,697	$37,697	0.563	$21,228
30			$62,997	$62,997	0.552	$34,779
					TOTAL PRESENT WORTH	**$2,770,734**

Cost Estimate - Alternative G-4

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-4: Natural Attenuation with Monitoring/LUCs
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans (LTM)	300	hr			$60.00		$0	$0	$18,000	$0	$18,000
1.2 Prepare LUC Documents	150	hr			$60.00		$0	$0	$9,000	$0	$9,000
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Mobilization/Demobilization HSA Sub	1	ea	$1,000.00				$1,000	$0	$0	$0	$1,000
3 SITE SUPPORT											
3.1 Equipment Decon Pad	1	ls		$1,850.00	$1,000.00	$300.00	$0	$1,850	$1,000	$300	$3,150
3.2 Underground Utility Clearances	1	ls	$7,500.00				$7,500	$0	$0	$0	$7,500
4 MNA WELLS											
4.1 Well Installation	150	lf	$10.00				$1,500	$0	$0	$0	$1,500
4.2 Well Heads	6	ea	$150.00				$900	$0	$0	$0	$900
4.3 IDW Disposal	6	drum	$200.00				$1,200	$0	$0	$0	$1,200
4.4 Pavement Coring & Repair	6	ea	$85.00				$510	$0	$0	$0	$510
5 NA BASELINE SAMPLING (2 events)											
5.1 NA Sampling Labor	320	hr			$37.50		$0	$0	$12,000	$0	$12,000
5.2 NA Sampling ODC	2	ea		$2,000.00			$0	$4,000	$0	$0	$4,000
5.3 NA Sampling Analysis	2	ea	$4,000.00				$8,000	$0	$0	$0	$8,000
5.4 NA Sampling Report	320	hr			$60.00		$0	$0	$19,200	$0	$19,200
Subtotal							$20,610	$5,850	$59,200	$300	$85,960

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-4: Natural Attenuation with Monitoring/LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @ 30%									$17,760		$17,760
G & A on Cost @ 10%							$2,061	$585	$5,920	$30	$8,596
Tax on Materials and Equipment Cost @ 6%								$351		$18	$369
Total Direct Cost							$22,671	$6,786	$82,880	$348	$112,685
Indirects on Total Direct Cost @ 25%											$28,171
Profit on Total Direct Cost @ 10%											$11,269
Total Field Cost											$152,125
Contingency on Total Field Costs @ 15%											$22,819
Engineering on Total Field Costs @ 7%											$10,649
TOTAL CAPITAL COST											**$185,592**

Item	Item Cost year 1	Item Cost years 2 & 3	Item Cost years 4 - 30	Item Cost every 5 years	Notes
Site Inspection: Visit & Report	$4,570	$4,570	$4,570		One-day visit to verify LUC & report.
Sample Collection	$54,800	$27,400	$13,700		Labor and supplies for groundwater samples using a crew of two, four times a year in year 1, twice a year in years 2 & 3, and once a year in years 4 through 30.
Analysis; Water	$16,000	$8,000	$4,000		Analyze groundwater samples for TCE, 1,1-DCA, n-nitroso-di-n-propylamine, MTBE, PCBs, Mn, and MNA parameters
Report	$48,000	$24,000	$12,000		
Site Review				$23,000	Five year review reports
Subtotal	$123,370	$63,970	$34,270	$23,000	
Contingency @ 10%	$12,337	$6,397	$3,427	$2,300	
TOTAL	**$135,707**	**$70,367**	**$37,697**	**$25,300**	

NAS SOUTH WEYMOUTH
Weymouth, Massachusetts
Building 82 FS
Alternative G-4: Natural Attenuation with Monitoring/LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$185,592		$185,592	1.000	$185,592
1		$135,707	$135,707	0.980	$133,046
2		$70,367	$70,367	0.961	$67,635
3		$70,367	$70,367	0.942	$66,308
4		$37,697	$37,697	0.924	$34,826
5		$62,997	$62,997	0.906	$57,058
6		$37,697	$37,697	0.888	$33,474
7		$37,697	$37,697	0.871	$32,818
8		$37,697	$37,697	0.853	$32,174
9		$37,697	$37,697	0.837	$31,543
10		$62,997	$62,997	0.820	$51,679
11		$37,697	$37,697	0.804	$30,318
12		$37,697	$37,697	0.788	$29,724
13		$37,697	$37,697	0.773	$29,141
14		$37,697	$37,697	0.758	$28,570
15		$62,997	$62,997	0.743	$46,808
16		$37,697	$37,697	0.728	$27,460
17		$37,697	$37,697	0.714	$26,922
18		$37,697	$37,697	0.700	$26,394
19		$37,697	$37,697	0.686	$25,876
20		$62,997	$62,997	0.673	$42,395
21		$37,697	$37,697	0.660	$24,872
22		$37,697	$37,697	0.647	$24,384
23		$37,697	$37,697	0.634	$23,906
24		$37,697	$37,697	0.622	$23,437
25		$62,997	$62,997	0.610	$38,399
26		$37,697	$37,697	0.598	$22,527
27		$37,697	$37,697	0.586	$22,085
28		$37,697	$37,697	0.574	$21,652
29		$37,697	$37,697	0.563	$21,228
30		$62,997	$62,997	0.552	$34,779
				TOTAL PRESENT WORTH	**$1,297,029**

APPENDIX G

MAINTENANCE ACTION RISK SCREENING EVALUATION

APPENDIX G
Building 82 Risk Screening Evaluation

Background Information

As mentioned in Sections 1 and 2 of this FS, a maintenance action was performed in 2010 to reduce levels of known contamination at selected soil and sediment locations to below the MCP S-1 criteria. The work was performed in accordance with the scope agreed upon by the Navy, EPA and MassDEP and described in the Work Plan (TtEC, 2010). The maintenance action included: completion of soil borings and soil sample collection; limited soil and sediment excavation in two areas; and removal of gas-trap manholes (GTMs) and associated piping followed by excavation of impacted soil. Confirmatory soil samples were collected from each excavation area. Details of the work, including removals, excavation, and investigatory and confirmation sample results are provided in the Final Maintenance Activities Completion Report (TtEC, 2011). The work is summarized below.

The maintenance action included advancement of 10 borings in August 2010 in and around the hangar: 4 borings near the location of MW-200 northwest of the hangar, and 6 borings inside the hangar near the former (now removed) floor drain system (FDS) (see Figure G-1). Four GTMs on the west side of the hangar (GTM-1 to GTM-4 on Figure G-1) and associated piping from the outer wall of the hangar out to the storm drain system were then removed. Soils were excavated to a depth of 15 feet. Approximately 416 cubic yards of soil were removed. Concentrations of confirmation samples collected at the base and sidewalls of the excavations were below the MCP S-1 cleanup criteria. The excavation was then backfilled with clean fill.

In September 2010, the Navy performed a Limited Removal Action on the apron (see Figure G-1). Soils were excavated in the northwestern side of the hangar apron, where the 2007 access road excavations had encountered petroleum-impacted material. The confirmation sample results met the MCP S-1 screening criteria and the excavation was then filled with clean fill material. Approximately 100 cubic yards of soil were removed. The Navy also returned to the drainage ditch north of Building 82 (Figure G-1), where PAHs had been detected in a sediment sample upstream of the Site. Fifteen linear feet of each drainage section were excavated to a depth of one foot below ground surface; approximately 50 cubic yards of sediment were removed. The confirmation sample results did not exceed the MCP S-1 screening criteria. The drainage ditch was re-sloped, lined with an erosion-protective fabric, and re-seeded once excavation was completed.

This risk screening evaluation was performed using the confirmation sample data set and associated RI data to support the completion of the maintenance action and reduction of contaminant levels in soils and sediment at the Site. Tables G-1 through G-19 present the data used in the evaluation and the results of the evaluation.

Risk Screening Steps

The steps in the risk screening are outlined below:

1) Detected concentrations of chemicals in each soil data set (Tables G-1 through G-4) were compared to residential screening criteria (based on United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for residential soil (USEPA, 2011)), presented in Table G-6, and NAS South Weymouth Base background concentrations (Stone and Webster, 2002) for chemical of potential concern (COPC) selection. Chemicals with maximum concentrations exceeding the risk-based screening criteria and available background values were selected as COPCs (Tables G-7 through G-11).
2) Human health risks and hazards were estimated for the selected COPCs using a risk ratio approach, as presented in Tables G-12 and G-13.
3) As part of the uncertainty discussion, for informational purposes, detected concentrations of chemicals in soil that exceeded the residential screening criteria but were less than background values were evaluated quantitatively (Tables G-14 through and G-16) to provide total risks (i.e., risks including chemicals attributable to background).

COPC Selection Methodology

- Four sub-areas were investigated: 1) the Apron Excavation Area; 2) the Ditch Excavation Area; 3) the Gas Trap Manhole (GTM) Excavation/Floor Drain System (FDS) Boring Area; and 4) the MW-200 Boring Area (see Figure G-1).
- The data evaluated were 2010 confirmatory sample soil data (floor and sidewall samples) as well as data for several samples collected during the 2006 Remedial Investigation (RI) that were located near or within the sub-areas being investigated and represent current site conditions (i.e., they were not from locations that have excavated).
- Surface soil (i.e., 0 to 2 feet below ground surface [bgs]) and subsurface soil (greater than 2 to 8 feet bgs) were evaluated separately because receptor exposure to surface soil is more likely under most scenarios (see Exposure Assessment). Soil greater than 8 feet bgs was considered to be saturated, as 8 feet bgs is the estimated average depth to the water table across the Site during low groundwater periods. It is assumed that soil below the water table will not be disturbed during construction, and thus receptors would not be exposed to soil below 8 feet bgs. However, chemical concentrations detected in saturated subsurface soil are discussed in the

Uncertainty Analysis for completeness. Sample lists for surface and subsurface soil evaluated in the risk ratio evaluation are presented in Tables G-1 through G-4. Available saturated subsurface soil samples evaluated in the Uncertainty Analysis are presented in Table G-5.

- The data sets were screened against residential criteria based on USEPA RSLs for residential soil (USEPA, 2011), as shown in Table G-6, and Base background concentrations where applicable (Stone and Webster, 2002). The RSLs for carcinogens correspond with a target cancer risk level of $1x10^{-6}$ (i.e., the one-in-one million cancer risk level). The RSLs for noncarcinogens correspond with a hazard quotient (HQ) of 1 (i.e., a no-adverse-effect concentration for a noncarcinogenic chemical). For COPC selection, RSLs for noncarcinogens were adjusted to represent an HQ of 0.1 to account for potential cumulative effects of several chemicals affecting the same target organ or producing the same adverse noncarcinogenic effect. The Base background concentrations are 95 percent upper prediction limits (UPLs) or maximum concentrations for surface or subsurface soil background data.
- A chemical was selected as a COPC if the maximum detected concentration was greater than the associated RSL-based screening level representing an incremental lifetime cancer risk (ILCR) of $1x10^{-6}$ or a noncancer HQ of 0.1 *and* the chemical was detected at concentrations exceeding background soil levels for NAS Weymouth.
- RSLs for the carbon chain parameters in the extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) fractions were not available. The EPH and VPH results were additionally screened against Massachusetts Contingency Plan (MCP) criteria in the Uncertainty Analysis for informational purposes.
- Detected chemicals without screening criteria were not selected as COPCs but are discussed in the Uncertainty Analysis.
- For certain polycyclic aromatic hydrocarbons (PAHs) that act via a mutagenic pathway [i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene], a toxicity equivalence factor (TEF) approach was used. TEFs are based on the relative potency of each of these compounds relative to that of benzo(a)pyrene and are used to convert each individual concentration into an equivalent concentration of benzo(a)pyrene. One-half of the method detection limit (MDL) was used to represent non-detected concentrations in the calculation. If all seven PAH compounds were not detected in a sample, then the MDL for benzo(a)pyrene was used as the equivalent concentration for that sample.
- For polychlorinated biphenyls (PCBs), individual Aroclors were compared to screening criteria for individual Aroclors. Total Aroclor concentrations were calculated for the sample data and are presented on the COPC selection tables as appropriate. The USEPA RSL for polychlorinated biphenyls (high risk) was used for total Aroclor in COPC selection. The PCBs Aroclor-1248, Aroclor-1254, and Aroclor-1260 were detected in soil samples used in this evaluation.

- COPC selection criteria for hexavalent chromium were used for total chromium. This conservative approach was taken because chromium speciation data are not available and chromium is considered more toxic in the hexavalent state.
- Calcium, magnesium, potassium, and sodium were not selected as COPCs because these metals are considered essential nutrients, are not typically evaluated quantitatively, and are only toxic at high doses.

COPC Selection Results

Apron Excavation Area

Table G-7 presents the results of COPC selection for the Apron Excavation Area subsurface soil. Samples from the Apron Excavation Area were analyzed for EPH and VPH. None of the detected concentrations exceeded available residential screening criteria based on the USEPA RSLs. Therefore, no COPCs were selected. However, RSLs are not available for the carbon chain parameters in the EPH and VPH fractions. Results for the EPH and VPH fractions are screened against the MCP S-1 soil criteria in the Uncertainty Analysis.

Ditch Excavation Area

Table G-8 presents the results of COPC selection for the Ditch Excavation Area surface soil. Samples from the Ditch Excavation Area were analyzed for PAHs. No detected concentrations exceeded both the risk-based residential screening criteria and background values; therefore, no chemicals were selected as COPCs. Note that although the calculated benzo(a)pyrene equivalents concentrations exceeded the risk-based screening level, it was assumed that benzo(a)pyrene equivalents would be less than background because the concentrations of all seven individual PAHs that act via a mutagenic pathway are less than their respective background concentrations. Chemicals with concentrations exceeding the screening criteria but within background values are evaluated in the Uncertainty Analysis.

GTM/FDS Area

- Table G-9 presents the results of COPC selection for GTM/FDS Area surface soil. The one surface soil sample was analyzed for metals, pesticides/PCBs, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). The following chemicals were detected at concentrations exceeding risk-based residential screening criteria and background values and were selected as COPCs:

- Metals: iron and manganese.
- Arsenic, chromium (evaluated using a risk-based criterion for hexavalent chromium), cobalt, and benzo(a)pyrene equivalents, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were eliminated from COPC selection based on screening against background values; a quantitative evaluation for these chemicals is presented in the Uncertainty Analysis.

- Table G-10 presents the results of COPC selection for GTM/FDS Area subsurface soil. Subsurface soil samples included in this data set were analyzed for EPH, metals, pesticides/PCBs, SVOCs, VPH, and VOCs. The following chemicals were detected at concentrations exceeding risk-based residential screening criteria and background values and were selected as COPCs:

    - EPH: benzo(a)pyrene equivalents, benzo(a)pyrene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.
    - Metals: aluminum, arsenic, chromium (using the hexavalent chromium risk-based criterion), cobalt, iron, and lead.
    - SVOCs: benzo(a)pyrene equivalents, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

  Additionally, benzo(a)anthracene and benzo(b)fluoranthene in the EPH fraction and manganese were eliminated from COPC selection based on screening against background concentrations. However, benzo(a)anthracene and benzo(b)fluoranthene concentrations are included in the benzo(a)pyrene equivalents concentration, and benzo(a)pyrene equivalents were selected as a COPC. Manganese is evaluated in the total risk evaluation presented in the Uncertainty Analysis.

<u>MW-200 Boring Area</u>

- Table G-11 presents the results of COPC selection for MW-200 Boring Area surface soil. VOCs analyzed in surface soil samples were included in this data set. No detected concentrations exceeded applicable screening criteria; therefore, no COPCs were selected for this data set.
- Only one sample (MW200-1 collected at 3 feet bgs) was considered subsurface soil for the MW-200 Boring Area. MW200-1 was analyzed for VOCs; however, no chemicals were detected in this sample. Therefore, no COPCs are selected for MW-200 Boring Area subsurface soil.

Exposure Assessment

- The evaluation assumed a hypothetical future resident as a receptor to be conservative and ensure that the Site is suitable for the future uses specified in the Zoning and Land use By-Laws. The site is located within the “Village Center District,” which is a mixed use zoning district including high-density housing, offices, commercial and retail uses.
- The evaluation also assumed that receptors may be exposed to chemicals in surface and subsurface soil via incidental ingestion, dermal contact, and inhalation.
- Exposure point concentrations (EPCs) were calculated for the COPCs in the soil data sets. The EPC was either the 95-percent upper confidence limit (UCL) on the mean or, if less than five samples or three positive detections were available, the maximum concentration in the data set. ProUCL version 4.1.00 (USEPA, 2010a) was used for the 95-percent UCL calculations. MDLs were used to represent non-detected values in the 95-percent UCL calculations. The averages of original and duplicate results were used to represent the results of field duplicate pairs in the 95-percent UCL calculations.
- All surface and subsurface soil was assumed to be accessible to receptors; however, soil at depth (e.g., greater than 2 feet bgs) would only be accessible if future construction brought the subsurface soil to the surface.
- USEPA RSLs for residential soil (USEPA, 2011) were used in the risk ratio evaluations for soil. These RSLs incorporate conservative USEPA-derived exposure assumptions protective of residential land use (e.g., an exposure frequency of 350 days per year).
- For some data sets, the same parameters were selected as COPCs in more than one fraction (e.g., benzo(a)pyrene equivalents in both the EPH and SVOC fractions). In these cases, the greater of the EPCs from the two fractions was used to represent that parameter in the risk ratio evaluation in order to be conservative.

Toxicity Assessment

- The USEPA RSLs incorporate current toxicity criteria from USEPA literature sources. The toxicity criteria used to calculate the RSLs are selected by the hierarchy specified in current USEPA guidance (USEPA, 2003).
- The seven PAHs that act via a mutagenic mode of action were evaluated as benzo(a)pyrene equivalents using one-half of the value for non-detected results in the calculation (i.e., ½ U).
- Total chromium results were conservatively evaluated using hexavalent chromium criteria. Chromium is considered more toxic in the hexavalent state than in the trivalent state.

Risk Characterization

- A risk ratio technique was used to estimate cancer risks and HQs. The cancer risk estimate = (EPC*1E-06)/cancer RSL, where 1E-06 is the target cancer risk level. The noncancer HQ = (EPC*1)/noncancer RSL, where 1 is the target HQ.
- Cancer risk estimates (i.e., ILCRs) were compared to the USEPA target cancer risk range of $1x10^{-4}$ to $1x10^{-6}$ (i.e., a one-in-ten-thousand to one-in-one-million chance of developing cancer under the exposure scenario). The MassDEP target cancer risk level is $1x10^{-5}$ (i.e., a one-in-one-hundred-thousand chance of developing cancer under the exposure scenario).
- HQs were summed to produce a hazard index (HI); HIs were compared to an HI of 1 (i.e., a no-adverse-effect concentration for a noncarcinogenic chemical). If an HI exceeded 1 for any medium, HIs were then developed on a target-organ specific basis and compared to 1. HQs and HIs are indicators of the potential for noncancer health effects.

Risk Characterization Results

As noted in the COPC Selection Results discussion above, COPCs were selected for just the GTM/FDS Area. Tables G-12 and G-13 present the estimated cancer risks and HIs for chemicals selected as COPCs in the GTM/FDS Area surface soil and subsurface soil data sets, respectively. The results are discussed in this section.

- Noncancer HIs were less than 1 for residential receptors exposed to chemicals in GTM/FDS Area surface soil and subsurface soil (Tables G-12 and G-13, respectively); thus, no adverse noncarcinogenic effects are anticipated under the defined exposure scenarios.
- No carcinogenic COPCs were selected for the GTM/FDS Area surface soil data set; therefore, carcinogenic risks were not calculated for surface soil (Table G-12).
- The cumulative ILCR for residential receptors exposed to chemicals in GTM/FDS subsurface soil was within the USEPA target cancer risk range ($1x10^{-4}$ to $1x10^{-6}$) (Table G-13). The benzo(a)pyrene equivalents were the primary risk drivers, with an individual ILCR of $9x10^{-5}$. The EPC for benzo(a)pyrene equivalents from the SVOC fraction was used for the risk ratio estimate instead of the EPC from the EPH fraction to be conservative, as the EPC from the SVOC fraction was greater. Because only two samples were analyzed for SVOCs, the maximum concentration was used as the EPC. Uncertainty associated with using the maximum concentration as the EPC is discussed in the Uncertainty Analysis. Additionally, note that the maximum concentrations for all individual PAHs in both the SVOC and EPH fractions are less than their MCP Method 1 Soil Category S-1 Standards, which are associated with the highest potential for receptor exposure (MassDEP, 2007).

- The results of the evaluation indicate that risks associated with GTM/FDS Area surface and subsurface soil are acceptable because cumulative cancer risks and HIs did not exceed the USEPA target cancer risk range ($1x10^{-4}$ to $1x10^{-6}$) or an HI of 1, respectively.
- Lead was selected as a COPC for GTM/FDS Area subsurface soil. The maximum concentration of lead in the GTM/FDS subsurface soil data (631 mg/kg) exceeds the screening criterion of 400 mg/kg, which is recommended by guidance from the USEPA Office of Prevention, Pesticides, and Toxic Substances (OPPTS) and Office of Solid Waste and Emergency Response (OSWER) as the lowest screening level for lead-contaminated soil in a residential setting where children are frequently present (USEPA, 1994). Lead cannot be evaluated using the risk ratio technique because no toxicity criteria are available for lead. In accordance with USEPA guidance (1994, 2010b), the arithmetic mean lead concentration was used as the EPC for lead. The arithmetic mean concentration for lead is 53.9 mg/kg, which is less than the screening criterion of 400 mg/kg. The maximum concentration of lead was detected in RI sample B82-SB-109, and nearby FDS samples had lead concentrations that were 6.5 mg/kg or less. Therefore, no adverse effects are anticipated due to lead, and lead was not further evaluated.

Uncertainty Analysis

- The benzo(a)pyrene equivalents used in the risk ratio evaluation were calculated using one-half the MDL for non-detected results (i.e., ½ U). This is more conservative than using a value of zero for non-detected results (i.e., 0 U). However, in either method, the MDL for benzo(a)pyrene was used as the benzo(a)pyrene equivalents concentration in samples where all seven related PAHs were non-detected. Statistics for benzo(a)pyrene equivalents using both calculation methods are presented on the COPC selection tables where applicable. In the data sets evaluated, the benzo(a)pyrene equivalents results are similar using both calculation methods. Therefore, using benzo(a)pyrene equivalents – ½ U in the risk evaluation does not add considerable uncertainty.
- The maximum concentration of benzo(a)pyrene equivalents from the SVOC fraction was used as the EPC for GTM/FDS Area subsurface soil because only two samples were analyzed for SVOCs. The EPCs for benzo(a)pyrene equivalents in the SVOC and EPH fractions were 1340 µg/kg and 577 µg/kg, respectively. The EPC for benzo(a)pyrene equivalents in the EPH fraction is also based on the maximum concentration because there were only two positive detections of the benzo(a)pyrene equivalents in the 16 available samples. Using the maximum concentration tends to overestimate potential risks because receptors are assumed to be continuously exposed to the maximum concentration for the entire exposure period. If the EPC from the EPH fraction were used to represent the benzo(a)pyrene equivalents, cumulative cancer risk for residents would be approximately $7x10^{-5}$.

- All soil to a depth of 8 feet bgs was assumed to be accessible to receptors; however, soil at depth (e.g., greater than 2 feet bgs) would only be accessible if future construction brought the subsurface soil to the surface.
- Chemical concentrations were screened against background values in the initial COPC selection step to determine which chemicals should be included in the quantitative risk assessment. Therefore, the risk estimates in Tables G-12 and G-13 represent site-related risks (i.e., those not attributable to background). In order to estimate total risks (i.e., site and background risks), risk ratio evaluations including chemicals eliminated as COPCs based on screening against background values are presented in Tables G-14 through G-16.

    - Table G-14 displays total risk estimates for Ditch Excavation Area surface soil. No COPCs were selected originally for Ditch Excavation Area surface soil. The benzo(a)pyrene equivalents and several related PAHs exceeded the risk-based screening criteria but were eliminated from COPC selection based on screening against background values. Therefore, Table G-14 presents the risk estimates for benzo(a)pyrene equivalents. No HI was calculated because no noncancer toxicity criteria are available for the benzo(a)pyrene equivalents. The cumulative ILCR of $9x10^{-6}$ is within the USEPA target cancer risk range.
    - Table G-15 displays total risk estimates for GTM/FDS Area surface soil. Benzo(a)pyrene equivalents and several related PAHs, arsenic, chromium, and cobalt were eliminated as COPCs based on screening against background values during the initial COPC selection process but are included in Table G-15. The cumulative HI is less than 1, indicating that adverse noncarcinogenic effects are not anticipated for residential receptors under the defined exposure scenario. The total ILCR is $3x10^{-5}$, which is within the USEPA target cancer risk range. The benzo(a)pyrene equivalents are the main contributor to the total ILCR, with an individual ILCR of $1.7x10^{-5}$. Maximum concentrations were used as the EPCs for all chemicals evaluated; the use of maximum concentrations as EPCs tends to overestimate risks. Additionally, total chromium was evaluated as hexavalent chromium; however, it is unlikely that all chromium is present in the hexavalent state.
    - Table G-16 displays total risk estimates for GTM/FDS Area subsurface soil. Manganese was eliminated as a COPC based on screening against background values during the initial COPC selection process but is included in Table G-16. As Table G-16 shows, the cumulative HI is less than 1. Manganese does not contribute to the total ILCR, so the cumulative ILCR remains as $1x10^{-4}$.

- USEPA RSLs are not available for the carbon chain parameters detected in the EPH and VPH fractions. Therefore, EPH and VPH results (included in the Apron Excavation Area subsurface soil and GTM/FDS Area subsurface soil data sets) were additionally screened against MCP S-1 Soil criteria (MassDEP, 2007) (Tables G-17 and G-18). Table G-17 shows that the maximum concentrations of all detected EPH and VPH parameters are less than the MCP criteria except for C5-C8 Aliphatics in the VPH fraction. Only the C5-C8 Aliphatics concentration detected in sample C-B82-APN-SW-14 exceeded the MCP criterion. Note however, that the maximum concentrations of other petroleum constituents in the VPH fraction (e.g., benzene, toluene, ethylbenzene, xylenes) are less than the MCP criteria. As discussed in the Maintenance Activities Completion Report, a hot spot evaluation was performed since further excavation along the side wall was not recommended due to site conditions including proximity to a gas line. The evaluation determined that a hot spot of contamination was not present near location C-B82-APN-SW-14, and a potential EPC calculated for C5-C8 Aliphatics for future site users was less than the MCP criterion, which indicates that no significant risk is expected for future site users (Tetra Tech, 2011). Table G-18 shows that all detected EPH and VPH parameters in the GTM/FDS Area subsurface soil data set have concentrations less than the MCP criteria.

- No screening criterion was available for carbazole, detected in the GTM/FDS Area subsurface soil data set in one of two samples at a concentration of 200 µg/kg. The lack of a screening criterion for carbazole is not expected to add considerable uncertainty to the risk screening evaluation because risk-based screening levels are available for most of the primary contaminants (in terms of concentration and frequency of detection; e.g., the PAHs).
- Soil samples collected from greater than 8 feet bgs (available for the GTM/FDS Area data set only) were excluded from the risk ratio evaluation because these samples are saturated and receptor exposure to saturated soil is unlikely. However, for completeness, the available saturated soil results for the GTM/FDS Area were compared to risk-based screening criteria and background values in Table G-19. As shown in Table G-19, aluminum, cobalt, iron, benzo(a)pyrene equivalents, benzo(a)pyrene, dibenzo(a,h)anthracene, and tetrachloroethene have concentrations in saturated soil that exceed the risk-based criteria and available background values. However, the maximum concentrations of aluminum (target organ: central nervous system), cobalt (target organ: thyroid), and iron (target organ: gastrointestinal system) do not exceed screening levels based on an HQ of 1 (instead of an HQ of 0.1, as in Table G-19), which indicates that adverse noncarcinogenic effects are not anticipated for these metals on a target organ-specific basis. The maximum concentration of aluminum in saturated soil is less than the maximum concentration of aluminum in unsaturated subsurface soil. The maximum concentrations of cobalt and iron in saturated subsurface soil are greater than, but within one order of magnitude of, the maximum concentrations of cobalt and iron in unsaturated subsurface soil. Additionally, the maximum concentrations of the PAHs were greater in unsaturated soil than in saturated soil; therefore, the quantitative risk ratio evaluation adequately accounted for these parameters. In contrast, the maximum concentration of tetrachloroethene was several orders of

magnitude greater in saturated soil (maximum = 1100 µg/kg) than in unsaturated soil (maximum = 1 µg/kg). In saturated soil, tetrachloroethene was detected in only 2 of 13 samples, and the second detected concentration was 1 µg/kg, which is significantly less than the maximum of 1100 µg/kg and the screening level of 550 µg/kg. If tetrachloroethene was included in the risk ratio evaluation using the maximum concentration as the EPC, the estimated cancer risk for soil exposure would not be significantly greater than the cancer risk currently estimated for the unsaturated soils, as the individual ILCR for tetrachloroethene would be approximately $2x10^{-6}$. The estimated HQ for tetrachloroethene (target organ: liver) would be 3 using the maximum concentration as the EPC. However, because of the low frequency of detection of tetrachloroethene, the localized nature of the exceedance, and the fact that the saturated soils are currently buried and below the groundwater table, receptor exposure to the elevated concentration of tetrachloroethene is unlikely.

Conclusions

The risk ratio evaluation performed using the surface and subsurface soil confirmatory sample results and RI samples, where applicable, indicates that the concentrations remaining in the four sub-areas evaluated would not result in an unacceptable risk for a future resident. Since the approved zoning for the site includes future residential use, an evaluation based on a residential land use scenario is also protective of any other potential future land uses. Based on the results of this risk ratio evaluation, the site can be considered suitable for uses allowed within the Village Center District.

References

MassDEP, 2007. Massachusetts Contingency Plan (MCP) Method 1: Soil Category S-1 Standards. 310 CMR 40.0000, 12/14/2007.

Stone and Webster, 2002. Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth, November.

TtEC (Tetra Tech EC, Inc.), 2010. Final Addendum Work Plan for Piping and Soil/Sediment Removal Activities at Building 82- Hangar 2. August 19.

Tetra Tech, 2011. Final Maintenance Activities Completion Report for Building 82/Hangar 2 (R1). Former Naval Air Station South Weymouth (NAS SOWEY), South Weymouth, Massachusetts. August.

USEPA, 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response, Washington, D.C. Directive 9355.4 12, July.

USEPA, 2003. Human Health Toxicity Values in Superfund Risk Assessments. Office of Superfund Remediation and Technology Innovation, OSWER 9285.7-53, Washington, D.C. December.

USEPA, 2010a. ProUCL Version 4.1.00 User Guide. Office of Research and Development, Washington, D.C. EPA/600/R-07/038, May.

USEPA, 2010b. Integrated Exposure Uptake Biokinetic Model for Lead in Children, Windows® version (IEUBKwin v 1.1 Build 11). February.

USEPA, 2011. Regional Screening Levels for Chemical Contaminants at Superfund Sites, prepared by Oak Ridge National Laboratory. http://epa-prgs.ornl.gov/chemicals/index.shtml. November.

TABLES

TABLE G-1

SOIL SAMPLES USED IN THE HUMAN HEALTH RISK RATIO EVALUATION - APRON EXCAVATION AREA
BUILDING 82 RISK SCREENING EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Sample Identifier	Depth (feet)	
	Top	Bottom
Subsurface Soil		
Confirmatory Samples[1]		
C-B82-APN-B-01	NA	6
C-B82-APN-B-02	NA	6
C-B82-APN-B-03	NA	6
C-B82-APN-B-04	NA	6
C-B82-APN-B-04-D	NA	6
C-B82-APN-SW-05	NA	5
C-B82-APN-SW-06	NA	5
C-B82-APN-SW-07	NA	5
C-B82-APN-SW-08	NA	5
C-B82-APN-SW-09	NA	5
C-B82-APN-SW-10	NA	5
C-B82-APN-SW-11	NA	5
C-B82-APN-SW-12	NA	5
C-B82-APN-SW-13	NA	5
C-B82-APN-SW-14	NA	5
C-B82-APN-SW-15	NA	5

1 - All samples collected as grab samples at the estimated depths.
NA = Not available.
See Maintenance Activities Completion Report (Tetra Tech, 2011) for sample locations and analytical data.

TABLE G-2

SOIL SAMPLES USED IN THE HUMAN HEALTH RISK RATIO EVALUATION - DITCH EXCAVATION AREA
BUILDING 82 RISK SCREENING EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Sample Identifier	Depth (feet)	
	Top	Bottom
Surface Soil		
Confirmatory Samples[1]		
C-B82-DC-B-1	NA	1
C-B82-DC-B-2	NA	1
C-B82-DC-B-3	NA	1
C-B82-DC-B-4	NA	1

1 - Grab samples collected at depth of excavation (e.g., 1 foot).
NA = Not available.

See Maintenance Activities Completion Report (Tetra Tech, 2011) for sample locations and analytical data.

TABLE G-3

SOIL SAMPLES USED IN THE HUMAN HEALTH RISK RATIO EVALUATION - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA
BUILDING 82 RISK SCREENING EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Sample Identifier	Depth (feet)	
	Top	**Bottom**
Surface Soil		
Remedial Investigation Samples		
B82-SO-110-0002	0	2
Subsurface Soil		
Confirmatory Samples(1)		
C-B82-GTM1-B-5	NA	5
C-B82-GTM1-B-5-D	NA	5
C-B82-GTM1-SW-01	NA	5
C-B82-GTM1-SW-02	NA	5
C-B82-GTM1-SW-03	NA	5
C-B82-GTM1-SW-04	NA	5
C-B82-GTM-2-B-5	NA	5
C-B82-GTM-2-SW-01	NA	5
C-B82-GTM-2-SW-02	NA	5
C-B82-GTM-2-SW-02-D	NA	5
C-B82-GTM-2-SW-03	NA	5
C-B82-GTM-2-SW-04	NA	5
C-B82-GTM2-SW-4-D	NA	5
C-B82-GTM3-B-5	NA	5
C-B82-GTM3-SW-01	NA	5
C-B82-GTM3-SW-02	NA	5
C-B82-GTM3-SW-03	NA	5
C-B82-GTM3-SW-04	NA	5
C-B82-GTM3-SW-04-D	NA	5
C-B82-GTM4-B-5	NA	5
C-B82-GTM4-SW-01	NA	5
C-B82-GTM4-SW-02	NA	5
C-B82-GTM4-SW-03	NA	5
C-B82-GTM4-SW-4	NA	5
FDS 4-1	NA	7
FDS 4-2	NA	7
FDS 4-3	NA	7
FDS 4-3-D	NA	7
FDS 4-4	NA	7
FDS-5	NA	7
FDS-6	NA	7
Remedial Investigation Samples		
B82-SO-106-0608	6	8
B82-SO-109-0608	6	8

1 - For GTM samples, assume bottom (B) and sidewall (SW) collected at approximately 5 feet below ground surface. For FDS samples, all soil borings were collected at groundwater interface, approximately 7 feet below ground surface.

NA = Not available.

See Maintenance Activities Completion Report (Tetra Tech, 2011) for sample locations and analytical data.

TABLE G-4

SOIL SAMPLES USED IN THE HUMAN HEALTH RISK RATIO EVALUATION - MW-200 AREA
BUILDING 82 RISK SCREENING EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Sample Identifier	Depth (feet)	
	Top	Bottom
Surface Soil		
Remedial Investigation Samples[1]		
B82-SS-MW200S-0002	0	2
Confirmatory Samples[2]		
MW200-2	NA	2
MW200-3	NA	2
MW200-4	NA	2
Subsurface Soil		
Confirmatory Samples[2]		
MW200-1	NA	3

1 - Samples from location B82-MW-200D were analyzed for miscellaneous parameters only; therefore, these samples were not included in the risk evaluation.

2 - Grab samples collected at depth indicated.

NA = Not available.

See Maintenance Activities Completion Report (Tetra Tech, 2011) for sample locations and analytical data.

TABLE G-5

SATURATED SOIL SAMPLES FOR UNCERTAINTY ANALYSIS - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Saturated Soil - For Uncertainty Analysis[(1)]		
Remedial Investigation Samples		
B82-SO-106-0810	8	10
B82-SO-107-0810	8	10
B82-SO-107-1012	10	12
B82-SO-108-0810	8	10
B82-SO-108-1012	10	12
B82-SO-108-1012-D	10	12
B82-SO-109-0810	8	10
B82-SO-110-1214	12	14
B82-SO-111-1214	12	14
B82-SO-111-1214-D	12	14
B82-SO-111-1416	14	16
B82-SO-112-1214	12	14
B82-SO-112-1416	14	16
B82-SO-113-1214	12	14
B82-SO-113-2830	28	30

1 - Saturated soil samples are evaluated in the Uncertainty Analysis only.

TABLE G-6

HUMAN HEALTH SCREENING CRITERIA FOR SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

CAS No.	Chemical	USEPA RSLs - Residential Soil (mg/kg)[1]
Volatile Organic Compounds		
75-34-3	1,1-Dichloroethane	3.3 C
71-55-6	1,1,1-Trichloroethane	8700 N
79-00-5	1,1,2-Trichloroethane	1.1 C
95-63-6	1,2,4-Trimethylbenzene	62 N
95-50-1	1,2-Dichlorobenzene	1900 N
106-46-7	1,4-Dichlorobenzene	2.4 C
78-93-3	2-Butanone	28000 N
67-64-1	Acetone	61000 N
75-15-0	Carbon Disulfide	820 N
108-90-7	Chlorobenzene	290 N
75-00-3	Chloroethane	15000 N
156-59-2	cis-1,2-Dichloroethene	160 N
100-41-4	Ethylbenzene	5.4 C
98-82-8	Isopropylbenzene	2100 N
75-09-2	Methylene Chloride	11 C
104-51-8	N-Butylbenzene	3900 N
103-65-1	N-Propylbenzene	3400 N
135-98-8	sec-Butylbenzene	NA
127-18-4	Tetrachloroethene	0.55 C
--	Total 1,2-dichloroethene	700 N[2]
156-60-5	trans-1,2-Dichloroethene	150 N
79-01-6	Trichloroethene	4.4 N[3]
Semivolatile Organic Compounds		
91-57-6	2-Methylnaphthalene	310 N
83-32-9	Acenaphthene	3400 N
208-96-8	Acenaphthylene	3400 N[4]
120-12-7	Anthracene	17000 N
56-55-3	Benzo(a)anthracene	0.15 C
50-32-8	Benzo(a)pyrene	0.015 C
205-99-2	Benzo(b)fluoranthene	0.15 C
191-24-2	Benzo(g,h,i)perylene	1700 N[5]
207-08-9	Benzo(k)fluoranthene	1.5 C
117-81-7	Bis(2-ethylhexyl)phthalate	35 C
85-68-7	Butyl Benzyl Phthalate	260 C
86-74-8	Carbazole	NA
218-01-9	Chrysene	15 C
53-70-3	Dibenzo(a,h)anthracene	0.015 C
206-44-0	Fluoranthene	2300 N
86-73-7	Fluorene	2300 N
193-39-5	Indeno(1,2,3-cd)pyrene	0.15 C
91-20-3	Naphthalene	3.6 C
85-01-8	Phenanthrene	1700 N[5]
108-95-2	Phenol	18000 N
129-00-0	Pyrene	1700 N

TABLE G-6

HUMAN HEALTH SCREENING CRITERIA FOR SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

CAS No.	Chemical	USEPA RSLs - Residential Soil (mg/kg)[1]
Pesticides/PCBs		
72-54-8	4,4'-DDD	2 C
50-29-3	4,4'-DDT	1.7 C
12672-29-6	Aroclor-1248	0.22 C
11097-69-1	Aroclor-1254	1.1 N[3]
11096-82-5	Aroclor-1260	0.22 C
319-85-7	beta-BHC	0.27 C
5103-74-2	gamma-Chlordane	1.6 C[6]
1024-57-3	Heptachlor Epoxide	0.053 C
1336-36-3	Total Aroclor	0.22 C[7]
Inorganics		
7429-90-5	Aluminum	77000 N
7440-36-0	Antimony	31 N
7440-38-2	Arsenic	0.39 C
7440-39-3	Barium	15000 N
7440-41-7	Beryllium	160 N
7440-43-9	Cadmium	70 N
7440-70-2	Calcium	NA
18540-29-9	Chromium	0.29 C[8]
7440-48-4	Cobalt	23 N
7440-50-8	Copper	3100 N
57-12-5	Cyanide	1600 N
7439-89-6	Iron	55000 N
7439-92-1	Lead	400
7439-95-4	Magnesium	NA
7439-96-5	Manganese	1800 N
7439-97-6	Mercury	23 N[9]
7440-02-0	Nickel	1500 N
7440-09-7	Potassium	NA
7782-49-2	Selenium	390 N
7440-22-4	Silver	390 N
7440-23-5	Sodium	NA
7440-28-0	Thallium	0.78 N
7440-62-2	Vanadium	390 N
7440-66-6	Zinc	23000 N

TABLE G-6

HUMAN HEALTH SCREENING CRITERIA FOR SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

CAS No.	Chemical	USEPA RSLs - Residential Soil (mg/kg)(1)
Extractable Petroleum Hydrocarbons		
56-55-3	Benzo(a)anthracene	0.15 C
50-32-8	Benzo(a)pyrene	0.015 C
205-99-2	Benzo(b)fluoranthene	0.15 C
191-24-2	Benzo(g,h,i)perylene	1700 N(5)
207-08-9	Benzo(k)fluoranthene	1.5 C
--	C11-C22 Aromatics	NA
--	C19-C36 Aliphatics	NA
--	C9-C18 Aliphatics	NA
218-01-9	Chrysene	15 C
53-70-3	Dibenzo(a,h)anthracene	0.015 C
206-44-0	Fluoranthene	2300 N
193-39-5	Indeno(1,2,3-cd)pyrene	0.15 C
85-01-8	Phenanthrene	1700 N(5)
129-00-0	Pyrene	1700 N
Volatile Petroleum Hydrocarbons		
--	C5-C8 Aliphatics	NA
--	C9-C10 Aromatics	NA
--	C9-C12 Aliphatics	NA
100-41-4	Ethylbenzene	5.4 C
--	m+p-Xylenes	590 N(10)
91-20-3	Naphthalene	3.6 C
95-47-6	o-Xylene	690 N

1 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, Hazard index (HI) = 1.0].
2 - The value is for 1,2-dichloroethene (mixed isomers).
3 - One-tenth the noncarcinogenic level is less than the carcinogenic level; therefore, the noncarcinogenic level is presented.
4 - The value for acenaphthene is used as a surrogate for acenaphthylene.
5 - The value for pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
6 - Value is for chlordane.
7 - The value is for polychlorinated biphenyls (high risk).
8 - The value is for hexavalent chromium.
9 - The value is for mercuric chloride (and other mercury salts).
10 - The value is for m-xylene.

C = Carcinogenic
CAS = Chemical Abstract Service
N = Noncarcinogenic
NA = Not available/not applicable

TABLE G-7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - APRON EXCAVQATION AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentration(4)	Adjusted USEPA RSL - Residential Soil(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Apron Excavation Area	**EXTRACTABLE PETROLEUM HYDROCARBONS**												
	--	C11-C22 Aromatics	15500 J	15500 J	UG/KG	C-B82-APN-SW-14	1/15	26500 - 37900	15500	NA	NA	No	NTX
	--	C9-C18 Aliphatics	62400	62400	UG/KG	C-B82-APN-SW-14	1/15	26500 - 37900	62400	NA	NA	No	NTX
	VOLATILE PETROLEUM HYDROCARBONS												
	--	C5-C8 Aliphatics	8530	176000	UG/KG	C-B82-APN-SW-14	3/15	2900 - 3850	176000	NA	NA	No	NTX
	--	C9-C10 Aromatics	1230	75500	UG/KG	C-B82-APN-SW-14	5/15	580 - 700	75500	NA	NA	No	NTX
	--	C9-C12 Aliphatics	2070 J	107000	UG/KG	C-B82-APN-SW-14	5/15	2900 - 3850	107000	NA	NA	No	NTX
	100-41-4	Ethylbenzene	97 J	4070	UG/KG	C-B82-APN-SW-14	3/15	120 - 190	4070	NA	5400 C	No	BSL
	--	m+p-Xylenes	1190	2600	UG/KG	C-B82-APN-SW-08	2/15	230 - 310	2600	4	59000 N(7)	No	BSL
	91-20-3	Naphthalene	879	879	UG/KG	C-B82-APN-SW-14	1/15	120 - 190	879	NA	3600 C	No	BSL
	--	o-Xylene	102 J	1200	UG/KG	C-B82-APN-SW-14	3/15	120 - 190	1200	4	69000 N	No	BSL

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
Values are for subsurface soil.
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level
and is greater than background.
7 - Value is for m-xylene.

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:
C-B82-APN-B-01
C-B82-APN-B-02
C-B82-APN-B-03
C-B82-APN-B-04
C-B82-APN-B-04-D
C-B82-APN-SW-05
C-B82-APN-SW-06
C-B82-APN-SW-07
C-B82-APN-SW-08
C-B82-APN-SW-09
C-B82-APN-SW-10
C-B82-APN-SW-11
C-B82-APN-SW-12
C-B82-APN-SW-13
C-B82-APN-SW-14
C-B82-APN-SW-15

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above screening level and background

For elimination as a COPC:
BSL = Below COPC screening level
NTX = No toxicity criteria

TABLE G-8

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DITCH EXCAVATION AREA SURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
Ditch Excavation Area	**POLYCYCLIC AROMATIC HYDROCARBONS**												
	91-57-6	2-Methylnaphthalene	33	33	UG/KG	C-B82-DC-B-3	1/4	7 - 8	33	NA	31000 N	No	BSL
	83-32-9	Acenaphthene	15	15	UG/KG	C-B82-DC-B-3	1/4	7 - 8	15	NA	340000 N	No	BSL
	208-96-8	Acenaphthylene	13	13	UG/KG	C-B82-DC-B-3	1/4	7 - 8	13	210	340000 N[7]	No	BSL, BKG
	120-12-7	Anthracene	29	29	UG/KG	C-B82-DC-B-3	1/4	7 - 8	29	170	1700000 N	No	BSL, BKG
	56-55-3	Benzo(a)anthracene	4.9 J	80	UG/KG	C-B82-DC-B-3	3/4	7 - 7	80	810	150 C	No	BSL, BKG
	50-32-8	Benzo(a)pyrene	4.2 J	88	UG/KG	C-B82-DC-B-3	3/4	7 - 7	88	1830	**15 C**	No	BKG
	--	Benzo(a)pyrene Equivalents-1/2 U	9.1	140	UG/KG	C-B82-DC-B-3	3/4	7 - 7	140	NA	**15 C**	No	BKG[8]
	--	Benzo(a)pyrene Equivalents-0 U	5.3	140	UG/KG	C-B82-DC-B-3	3/4	7 - 7	140	NA	**15 C**	No	BKG[8]
	205-99-2	Benzo(b)fluoranthene	6.2 J	162	UG/KG	C-B82-DC-B-3	3/4	7 - 7	162	770	**150 C**	No	BKG
	191-24-2	Benzo(g,h,i)perylene	4.2 J	80	UG/KG	C-B82-DC-B-3	3/4	7 - 7	80	310	170000 N[9]	No	BSL, BKG
	207-08-9	Benzo(k)fluoranthene	6.7 J	43	UG/KG	C-B82-DC-B-3	2/4	7 - 7	43	2700	1500 C	No	BSL, BKG
	218-01-9	Chrysene	4.2 J	98	UG/KG	C-B82-DC-B-3	3/4	7 - 7	98	1400	15000 C	No	BSL, BKG
	53-70-3	Dibenzo(a,h)anthracene	17	17	UG/KG	C-B82-DC-B-3	1/4	7 - 8	17	96	**15 C**	No	BKG
	206-44-0	Fluoranthene	8.4	207	UG/KG	C-B82-DC-B-3	4/4	-	207	2400	230000 N	No	BSL, BKG
	86-73-7	Fluorene	19	19	UG/KG	C-B82-DC-B-3	1/4	7 - 8	19	NA	230000 N	No	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	14	104	UG/KG	C-B82-DC-B-3	2/4	7 - 7	104	175	150 C	No	BSL, BKG
	91-20-3	Naphthalene	14	14	UG/KG	C-B82-DC-B-3	1/4	7 - 8	14	NA	3600 C	No	BSL
	85-01-8	Phenanthrene	5.9 J	98	UG/KG	C-B82-DC-B-3	4/4	-	98	1500	170000 N[9]	No	BSL, BKG
	129-00-0	Pyrene	7.2	229	UG/KG	C-B82-DC-B-3	4/4	-	229	1500	170000 N	No	BSL, BKG

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002). Values are for surface soil.
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is greater than background.
7 - The value for acenaphthene is used as a surrogate for acenaphthylene.
8 - Benzo(a)pyrene equivalents are assumed to be less than background because all individual constituents have maximum concentrations less than respective background values.
9 - The value for pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:
C-B82-DC-B-1
C-B82-DC-B-2
C-B82-DC-B-3
C-B82-DC-B-4

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above screening level and background

For elimination as a COPC:
BKG = Less than background concentration
BSL = Below screening level

TABLE G-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA
BUILDING 82 RISK RATIO EVALUATION
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
GTM/FDS Area	**METALS**												
	7429-90-5	Aluminum	4990	4990	MG/KG	B82-SO-110-0002	1/1	-	4990	10500	7700 N	No	BSL, BKG
	7440-38-2	Arsenic	0.962	0.962	MG/KG	B82-SO-110-0002	1/1	-	0.962	5.3	**0.39 C**	No	BKG
	7440-39-3	Barium	30.7	30.7	MG/KG	B82-SO-110-0002	1/1	-	30.7	49.9	1500 N	No	BSL, BKG
	7440-41-7	Beryllium	0.9 J	0.9 J	MG/KG	B82-SO-110-0002	1/1	-	0.9	**0.3**	16 N	No	BSL
	7440-43-9	Cadmium	0.735	0.735	MG/KG	B82-SO-110-0002	1/1	-	0.735	0.9	7 N	No	BSL, BKG
	7440-70-2	Calcium	2200	2200	MG/KG	B82-SO-110-0002	1/1	-	2200	6360	NA	No	NUT, BKG
	18540-29-9	Chromium	2.71 J	2.71 J	MG/KG	B82-SO-110-0002	1/1	-	2.71	10	**0.29 C[7]**	No	BKG
	7440-48-4	Cobalt	2.55 J	2.55 J	MG/KG	B82-SO-110-0002	1/1	-	2.55	4.0	**2.3 N**	No	BKG
	7440-50-8	Copper	6.99	6.99	MG/KG	B82-SO-110-0002	1/1	-	6.99	26.2	310 N	No	BSL
	57-12-5	Cyanide	0.11	0.11	MG/KG	B82-SO-110-0002	1/1	-	0.11	NA	160 N	No	BSL
	7439-89-6	**Iron**	15200	15200	MG/KG	B82-SO-110-0002	1/1	-	15200	**11300**	**5500 N**	**Yes**	ASL
	7439-92-1	Lead	3.11 J	3.11 J	MG/KG	B82-SO-110-0002	1/1	-	3.11	302	400	No	BSL, BKG
	7439-95-4	Magnesium	929 J	929 J	MG/KG	B82-SO-110-0002	1/1	-	929	1960	NA	No	NUT, BKG
	7439-96-5	**Manganese**	437	437	MG/KG	B82-SO-110-0002	1/1	-	437	**314**	**180 N**	**Yes**	ASL
	7440-02-0	Nickel	4.46 J	4.46 J	MG/KG	B82-SO-110-0002	1/1	-	4.46	17.2	150 N	No	BSL, BKG
	7440-09-7	Potassium	261 J	261 J	MG/KG	B82-SO-110-0002	1/1	-	261	631	NA	No	NUT, BKG
	7782-49-2	Selenium	0.567	0.567	MG/KG	B82-SO-110-0002	1/1	-	0.567	3	39 N	No	BSL, BKG
	7440-22-4	Silver	0.142 J	0.142 J	MG/KG	B82-SO-110-0002	1/1	-	0.142	NA	39 N	No	BSL
	7440-28-0	Thallium	0.0171 J	0.0171 J	MG/KG	B82-SO-110-0002	1/1	-	0.0171	1.8	0.078 N	No	BSL, BKG
	7440-62-2	Vanadium	8.91	8.91	MG/KG	B82-SO-110-0002	1/1	-	8.91	89.1	39 N	No	BSL, BKG
	7440-66-6	Zinc	73.4 J	73.4 J	MG/KG	B82-SO-110-0002	1/1	-	73.4	73.8	2300 N	No	BSL, BKG
	PESTICIDES/PCBS												
	11096-82-5	Aroclor-1260	18	18	UG/KG	B82-SO-110-0002	1/1	-	18	106	220 C	No	BSL, BKG
	319-85-7	beta-BHC	0.88 J	0.88 J	UG/KG	B82-SO-110-0002	1/1	-	0.88	NA	270 C	No	BSL
	1336-36-3	Total Aroclor	18	18	UG/KG	B82-SO-110-0002	1/1	-	18	NA	220 C[8]	No	BSL
	SEMIVOLATILES												
	208-96-8	Acenaphthylene	13	13	UG/KG	B82-SO-110-0002	1/1	-	13	210	340000 N[9]	No	BSL, BKG
	120-12-7	Anthracene	16	16	UG/KG	B82-SO-110-0002	1/1	-	16	170	1700000 N	No	BSL, BKG
	--	Benzo(a)pyrene Equivalents-1/2 U	257	257	UG/KG	B82-SO-110-0002	1/1	-	257	NA	**15 C**	No	BKG[10]
	--	Benzo(a)pyrene Equivalents-0 U	257	257	UG/KG	B82-SO-110-0002	1/1	-	257	NA	**15 C**	No	BKG[10]
	56-55-3	Benzo(a)anthracene	56	56	UG/KG	B82-SO-110-0002	1/1	-	56	810	150 C	No	BSL, BKG
	50-32-8	Benzo(a)pyrene	180	180	UG/KG	B82-SO-110-0002	1/1	-	180	1830	**15 C**	No	BKG
	205-99-2	Benzo(b)fluoranthene	190	190	UG/KG	B82-SO-110-0002	1/1	-	190	770	**150 C**	No	BKG
	191-24-2	Benzo(g,h,i)perylene	150	150	UG/KG	B82-SO-110-0002	1/1	-	150	310	170000 N[11]	No	BSL, BKG
	207-08-9	Benzo(k)fluoranthene	70	70	UG/KG	B82-SO-110-0002	1/1	-	70	2700	1500 C	No	BSL, BKG
	218-01-9	Chrysene	69	69	UG/KG	B82-SO-110-0002	1/1	-	69	1400	15000 C	No	BSL, BKG
	53-70-3	Dibenzo(a,h)anthracene	39	39	UG/KG	B82-SO-110-0002	1/1	-	39	96	**15 C**	No	BKG
	206-44-0	Fluoranthene	40	40	UG/KG	B82-SO-110-0002	1/1	-	40	2400	230000 N	No	BSL, BKG
	193-39-5	Indeno(1,2,3-cd)pyrene	130	130	UG/KG	B82-SO-110-0002	1/1	-	130	175	150 C	No	BSL, BKG
	85-01-8	Phenanthrene	13	13	UG/KG	B82-SO-110-0002	1/1	-	13	1500	170000 N[11]	No	BSL, BKG
	129-00-0	Pyrene	39	39	UG/KG	B82-SO-110-0002	1/1	-	39	1500	170000 N	No	BSL, BKG

TABLE G-9

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA
BUILDING 82 RISK RATIO EVALUATION
NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
Values are for surface soil.
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level
and is greater than background.
7 - The value is for hexavalent chromium.
8 - The value is for polychlorinated biphenyls (high risk).
9 - The value for acenaphthene is used as a surrogate for acenaphthylene.
10 - Benzo(a)pyrene equivalents are assumed to be less than background because all individual constituents have maximum concentrations less than respective background values.
11 - The value for pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:
B82-SO-110-0002

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above screening level and background

For elimination as a COPC:
BKG = Less than background concentration
BSL = Below screening level
NUT = Essential nutrient

TABLE G-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
GTM/FDS Area	**EXTRACTABLE PETROLEUM HYDROCARBONS**												
	--	**Bap Equivalent-1/2 U**	336	577	UG/KG	FDS-6	2/16	264 - 336	577	NA	**15 C**	**Yes**	ASL
	--	**Bap Equivalent-0 U**	71.6	561	UG/KG	FDS-6	2/16	264 - 336	561	NA	**15 C**	**Yes**	ASL
	56-55-3	Benzo(a)anthracene	199 J	271 J	UG/KG	FDS-6	2/16	264 - 336	271	600	**150 C**	No	BKG
	50-32-8	**Benzo(a)pyrene**	343	343	UG/KG	FDS-6	1/16	264 - 336	343	**16**	**15 C**	**Yes**	ASL
	205-99-2	Benzo(b)fluoranthene	354	441	UG/KG	C-B82-GTM1-B-5	1/16	264 - 336	441	810	**150 C**	No	BKG
	191-24-2	Benzo(g,h,i)perylene	161 J	262 J	UG/KG	FDS-6	2/16	264 - 336	262	330	170000 N[7]	No	BSL, BKG
	207-08-9	Benzo(k)fluoranthene	145 J	168 J	UG/KG	C-B82-GTM1-B-5	1/16	264 - 336	168	320	1500 C	No	BSL, BKG
	--	C11-C22 Aromatics	82800	113000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	113000	NA	NA	No	NTX
	--	C19-C36 Aliphatics	105000	111000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	111000	NA	NA	No	NTX
	--	C9-C18 Aliphatics	598000	656000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	656000	NA	NA	No	NTX
	218-01-9	Chrysene	303	396	UG/KG	C-B82-GTM1-B-5	2/16	264 - 336	396	710	15000 C	No	BSL, BKG
	53-70-3	**Dibenzo(a,h)anthracene**	149 J	149 J	UG/KG	FDS-6	1/16	264 - 336	149	**1.7**	**15 C**	**Yes**	ASL
	206-44-0	Fluoranthene	198 J	763	UG/KG	FDS-6	2/16	264 - 336	763	1100	230000 N	No	BSL, BKG
	193-39-5	**Indeno(1,2,3-cd)pyrene**	145 J	412	UG/KG	FDS-6	2/16	264 - 336	412	**390**	**150 C**	**Yes**	ASL
	85-01-8	Phenanthrene	598	598	UG/KG	FDS-6	1/16	264 - 336	598	**360**	170000 N[7]	No	BSL
	129-00-0	Pyrene	189 J	612	UG/KG	FDS-6	2/16	264 - 336	612	1000	170000 N	No	BSL, BKG
	METALS												
	7429-90-5	**Aluminum**	3100	9200	MG/KG	FDS 4-3	13/13	-	9200	**8520**	**7700 N**	**Yes**	ASL
	7440-36-0	Antimony	0.58 J	0.82 J	MG/KG	C-B82-GTM-2-SW-04	2/13	0.0168 - 0.64	0.82	3.7	3.1 N	No	BSL, BKG
	7440-38-2	**Arsenic**	0.89 J	2.75	MG/KG	B82-SO-109-0608	12/13	0.71 - 0.71	2.75	**1.9**	**0.39 C**	**Yes**	ASL
	7440-39-3	Barium	12	26	MG/KG	FDS 4-3	13/13	-	26	27.0	1500 N	No	BSL, BKG
	7440-41-7	Beryllium	0.162 J	1.1	MG/KG	C-B82-GTM-2-SW-04	12/13	0.021 - 0.021	1.1	**0.44**	16 N	No	BSL
	7440-43-9	Cadmium	0.1	0.75 J	MG/KG	C-B82-GTM-2-SW-04	4/13	0.098 - 0.12	0.75	**0.115**	7 N	No	BSL
	7440-70-2	Calcium	960	2300	MG/KG	C-B82-GTM-2-SW-01	13/13	-	2300	**1550**	NA	No	NUT
	18540-29-9	**Chromium**	3	11	MG/KG	FDS 4-3	13/13	-	11	**10.2**	**0.29 C[8]**	**Yes**	ASL
	7440-48-4	**Cobalt**	1.8	5.31 J	MG/KG	B82-SO-109-0608	13/13	-	5.31	**4.7**	**2.3 N**	**Yes**	ASL
	7440-50-8	Copper	3.1	11.9 J	MG/KG	B82-SO-109-0608	13/13	-	11.9	14.2	310 N	No	BSL, BKG
	57-12-5	Cyanide	0.1 J	0.15	MG/KG	B82-SO-109-0608	2/2	-	0.15	0.22	160 N	No	BSL, BKG
	7439-89-6	**Iron**	5700	18200	MG/KG	B82-SO-109-0608	13/13	-	18200	**11450**	**5500 N**	**Yes**	ASL
	7439-92-1	**Lead**	2.5	631 J	MG/KG	B82-SO-109-0608	13/13	-	631	**9.3**	**400**	**Yes**	ASL
	7439-95-4	Magnesium	692 J	3500	MG/KG	FDS 4-3	13/13	-	3500	**2250**	NA	No	NUT
	7439-96-5	Manganese	67	260	MG/KG	C-B82-GTM-2-SW-02	13/13	-	260	414	**180 N**	No	BKG
	7439-97-6	Mercury	0.0096 J	0.017 J	MG/KG	FDS-5	5/13	0.00574 - 0.01	0.017	0.11	2.3 N[9]	No	BSL, BKG
	7440-02-0	Nickel	2.5 J	8.1	MG/KG	FDS 4-3	13/13	-	8.1	**6.5**	150 N	No	BSL
	7440-09-7	Potassium	157 J	510	MG/KG	C-B82-GTM-2-SW-02	13/13	-	510	**457**	NA	No	NUT
	7782-49-2	Selenium	0.371	1	MG/KG	FDS-5	2/13	0.185 - 1.2	1	**0.41**	39 N	No	BSL
	7440-22-4	Silver	0.0623 J	0.0898 J	MG/KG	B82-SO-106-0608	2/13	0.094 - 0.12	0.0898	0.28	39 N	No	BSL, BKG
	7440-23-5	Sodium	31.5 J	31.5 J	MG/KG	B82-SO-109-0608	1/13	33.7 - 99	31.5	144	NA	No	NUT, BKG
	7440-28-0	Thallium	0.0279 J	0.0279 J	MG/KG	B82-SO-106-0608	1/13	0.0183 - 1.2	0.0279	0.22	0.078 N	No	BSL, BKG
	7440-62-2	Vanadium	8.7	20.7	MG/KG	B82-SO-109-0608	13/13	-	20.7	**17.1**	39 N	No	BSL
	7440-66-6	Zinc	19	144 J	MG/KG	B82-SO-109-0608	13/13	-	144	**28.7**	2300 N	No	BSL

TABLE G-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
GTM/FDS Area		**PESTICIDES/PCBS**											
	50-29-3	4,4'-DDT	4.2	4.2	UG/KG	B82-SO-109-0608	1/2	1.7 - 1.7	4.2	4.6	1700 C	No	BSL, BKG
	11096-82-5	Aroclor-1260	27 J	27 J	UG/KG	B82-SO-106-0608	1/2	19 - 19	27	NA	220 C	No	BSL
	5103-74-2	gamma-Chlordane	1.4 J	1.4 J	UG/KG	B82-SO-109-0608	1/2	0.87 - 0.87	1.4	NA	1600 C[10]	No	BSL
	1336-36-3	Total Aroclor	27	27	UG/KG	B82-SO-106-0608	1/2	19 - 19	27	NA	220 C[11]	No	BSL
		SEMIVOLATILES											
	91-57-6	2-Methylnaphthalene	4.5	28	UG/KG	B82-SO-106-0608	2/2	-	28	NA	31000 N	No	BSL
	83-32-9	Acenaphthene	15	16	UG/KG	B82-SO-106-0608	2/2	-	16	NA	340000 N	No	BSL
	208-96-8	Acenaphthylene	7.1	290	UG/KG	B82-SO-109-0608	2/2	-	290	NA	340000 N[12]	No	BSL
	120-12-7	Anthracene	42	280 J	UG/KG	B82-SO-109-0608	2/2	-	280	NA	1700000 N	No	BSL
	--	**Benzo(a)pyrene Equivalents-1/2 U**	87.5	1340	UG/KG	B82-SO-109-0608	2/2	-	1340	NA	**15 C**	**Yes**	ASL
	--	**Benzo(a)pyrene Equivalents-0 U**	87.5	1340 J	UG/KG	B82-SO-109-0608	2/2	-	1340	NA	**15 C**	**Yes**	ASL
	56-55-3	**Benzo(a)anthracene**	66	1000 J	UG/KG	B82-SO-109-0608	2/2	-	1000	**600**	**150 C**	**Yes**	ASL
	50-32-8	**Benzo(a)pyrene**	58	820 J	UG/KG	B82-SO-109-0608	2/2	-	820	**16**	**15 C**	**Yes**	ASL
	205-99-2	**Benzo(b)fluoranthene**	79	1300 J	UG/KG	B82-SO-109-0608	2/2	-	1300	**810**	**150 C**	**Yes**	ASL
	191-24-2	Benzo(g,h,i)perylene	40	350 J	UG/KG	B82-SO-109-0608	2/2	-	350	**330**	170000 N[7]	No	BSL
	207-08-9	Benzo(k)fluoranthene	32	520 J	UG/KG	B82-SO-109-0608	2/2	-	520	**320**	1500 C	No	BSL
	117-81-7	Bis(2-ethylhexyl)phthalate	120 J	120 J	UG/KG	B82-SO-109-0608	1/2	340 - 340	120	205	35000 C	No	BSL, BKG
	85-68-7	Butyl Benzyl Phthalate	78 J	78 J	UG/KG	B82-SO-109-0608	1/2	340 - 340	78	200	260000 C	No	BSL, BKG
	86-74-8	Carbazole	200 J	200 J	UG/KG	B82-SO-109-0608	1/2	340 - 340	200	NA	NA	No	NTX
	218-01-9	Chrysene	72	1200 J	UG/KG	B82-SO-109-0608	2/2	-	1200	**710**	15000 C	No	BSL
	53-70-3	**Dibenzo(a,h)anthracene**	11	240	UG/KG	B82-SO-109-0608	2/2	-	240	**1.7**	**15 C**	**Yes**	ASL
	206-44-0	Fluoranthene	170	2600 J	UG/KG	B82-SO-109-0608	2/2	-	2600	**1100**	230000 N	No	BSL
	86-73-7	Fluorene	22	120	UG/KG	B82-SO-109-0608	2/2	-	120	NA	230000 N	No	BSL
	193-39-5	**Indeno(1,2,3-cd)pyrene**	36	400 J	UG/KG	B82-SO-109-0608	2/2	-	400	**390**	**150 C**	**Yes**	ASL
	91-20-3	Naphthalene	7.4	14	UG/KG	B82-SO-106-0608	2/2	-	14	NA	3600 C	No	BSL
	85-01-8	Phenanthrene	170	1200 J	UG/KG	B82-SO-109-0608	2/2	-	1200	**360**	170000 N[7]	No	BSL
	129-00-0	Pyrene	130	1700 J	UG/KG	B82-SO-109-0608	2/2	-	1700	**1000**	170000 N	No	BSL
		VOLATILE PETROLEUM HYDROCARBONS											
	--	C9-C10 Aromatics	2250	67500	UG/KG	C-B82-GTM1-B-5	2/17	520 - 740	67500	NA	NA	No	NTX
	--	C9-C12 Aliphatics	3640	92700	UG/KG	C-B82-GTM1-B-5	2/17	2600 - 3700	92700	NA	NA	No	NTX
	91-20-3	Naphthalene	393	488	UG/KG	C-B82-GTM1-B-5	2/17	100 - 150	488	NA	3600 C	No	BSL

TABLE G-10

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentration(4)	Adjusted USEPA RSL - Residential Soil(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
GTM/FDS Area	**VOLATILES**												
	71-55-6	1,1,1-Trichloroethane	4.8	4.8	UG/KG	C-B82-GTM1-SW-03, C-B82-GTM-2-SW-03	2/23	1.8 - 4	4.8	NA	870000 N	No	BSL
	75-34-3	1,1-Dichloroethane	2.4	2.4	UG/KG	C-B82-GTM1-SW-03, C-B82-GTM-2-SW-03	2/23	1.8 - 4	2.4	NA	3300 C	No	BSL
	67-64-1	Acetone	15	52	UG/KG	C-B82-GTM3-SW-02	21/23	4 - 4	52	59.8	6100000 N	No	BSL, BKG
	75-15-0	Carbon Disulfide	2	2	UG/KG	C-B82-GTM1-B-5	1/23	1.7 - 4	2	NA	82000 N	No	BSL
	75-09-2	Methylene Chloride	1 J	27	UG/KG	C-B82-GTM4-SW-02	20/23	9.1 - 14	27	NA	11000 C	No	BSL
	127-18-4	Tetrachloroethene	1	1	UG/KG	C-B82-GTM-2-SW-04, C-B82-GTM3-SW-04, C-B82-GTM4-SW-4	3/23	1.7 - 4	1	6	550 C	No	BSL, BKG

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002). Values are for subsurface soil.
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is greater than background.
7 - The value for pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
8 - The value is for hexavalent chromium.
9 - The value is for mercuric chloride (and other mercury salts).
10 - The value is for chlordane.
11 - The value is for polychlorinated biphenyls (high risk).
12 - The value for acenaphthene is used as a surrogate for acenaphthylene.
Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:

B82-SO-106-0608	C-B82-GTM-2-SW-03	C-B82-GTM4-SW-03
B82-SO-109-0608	C-B82-GTM-2-SW-04	C-B82-GTM4-SW-4
C-B82-GTM1-B-5	C-B82-GTM-2-SW-04-D	FDS 4-1
C-B82-GTM1-B-5-D	C-B82-GTM3-B-5	FDS 4-2
C-B82-GTM1-SW-01	C-B82-GTM3-SW-01	FDS 4-3
C-B82-GTM1-SW-02	C-B82-GTM3-SW-02	FDS 4-3-D
C-B82-GTM1-SW-03	C-B82-GTM3-SW-03	FDS 4-4
C-B82-GTM1-SW-04	C-B82-GTM3-SW-04	FDS-5
C-B82-GTM-2-B-5	C-B82-GTM3-SW-04-D	FDS-6
C-B82-GTM-2-SW-01	C-B82-GTM4-B-5	
C-B82-GTM-2-SW-02	C-B82-GTM4-SW-01	
C-B82-GTM-2-SW-02-D	C-B82-GTM4-SW-02	

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above screening level and background

For elimination as a COPC:
BKG = Less than background concentration
BSL = Below screening level
NUT = Essential nutrient
NTX = No toxicity criteria

TABLE G-11

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - MW-200 BORING AREA SURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentration(4)	Adjusted USEPA RSL - Residential Soil(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
MW-200 Boring Area	**VOLATILES**												
	95-50-1	1,2-Dichlorobenzene	110 J	110 J	UG/KG	B82-SS-MW200S-0002	1/4	1.9 - 2.8	110	NA	190000 N	No	BSL
	106-46-7	1,4-Dichlorobenzene	9 J	9 J	UG/KG	B82-SS-MW200S-0002	1/4	1.9 - 2.8	9	NA	2400 C	No	BSL
	67-64-1	Acetone	11	11	UG/KG	MW200-2	1/4	4 - 14	11	2200	6100000 N	No	BSL, BKG
	108-90-7	Chlorobenzene	71 J	71 J	UG/KG	B82-SS-MW200S-0002	1/4	1.9 - 2.8	71	NA	29000 N	No	BSL

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
Values are for surface soil.
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level
and is greater than background.

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:
B82-SS-MW200S-0002
MW200-2
MW200-3

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above screening level and background

For elimination as a COPC:
BKG = Less than background concentration
BSL = Below screening level
NTX = No toxicity criteria

TABLE G-12

RISK CHARACTERIZATION - SITE-RELATED RISKS - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
Chemical	**EPC: Maximum Concentration[1] (mg/kg)**	**Residential Soil RSL[2] (mg/kg)**	**Estimated ILCR**	**Primary Target Organs**	**Residential Soil RSL[2] (mg/kg)**	**Estimated HQ**
Iron	15200	NA	NA	Gastrointestinal System	55000	0.28
Manganese	437	NA	NA	Central Nervous System	1800	0.24
		Total ILCR	NA		**Total HI**	0.5

1 - The maximum concentration is used in place of the 95% UCL because there are fewer than 5 samples in the dataset.
2 - Source: USEPA, November 2011.

EPC = Exposure Point Concentration
HI = Hazard Index
HQ = Hazard Quotient
ILCR = Incremental Lifetime Carcinogenic Risk
RSL = Regional Screening Level

TABLE G-13

RISK CHARACTERIZATION - SITE-RELATED RISKS - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	EPC: 95% UCL or Maximum Concentration(1) (mg/kg)	Residential Soil RSL(2) (mg/kg)	Estimated ILCR	Primary Target Organs	Residential Soil RSL(2) (mg/kg)	Estimated HQ
Benzo(a)pyrene Equivalents-1/2 U(3)(4)	1.34	0.015	8.9E-05	NA	NA	NA
Aluminum	5850	NA	NA	Central Nervous System	77000	0.08
Arsenic	1.77	0.39	4.5E-06	Skin, Cardiovascular System	22	0.08
Chromium(5)	6.8	0.29	2.3E-05	Respiratory	230	0.030
Cobalt	3.75	370	1.0E-08	Thyroid	23	0.16
Iron	11740	NA	NA	Gastrointestinal System	55000	0.21
		Total ILCR	1E-04		Total HI	0.6

1 - The maximum concentration is used in place of the 95% UCL if there are fewer than 5 samples or 3 positive detections in a dataset or if the 95% UCL is greater than the maximum concentration.
2 - Source: USEPA, November 2011.
3 - Benzo(a)pyrene equivalents was selected as a COPC in both the EPH and SVOC fractions; the benzo(a)pyrene equivalents value presented is from the SVOC fraction to be conservative due to the greater EPC.
4 - The maximum concentration was used as the EPC.
5 - Total chromium is conservatively evaluated using criteria for hexavalent chromium.

COPC = Chemical of Potential Concern
EPC = Exposure Point Concentration
EPH = Extractable Petroleum Hydrocarbon
HI = Hazard Index
HQ = Hazard Quotient
ILCR = Incremental Lifetime Carcinogenic Risk
SVOC = Semivolatile Organic Compound
UCL = Upper Confidence Limit

TABLE G-14

RISK CHARACTERIZATION - DITCH EXCAVATION AREA SURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	EPC: Maximum Concentration[1] (mg/kg)	Residential Soil RSL[2] (mg/kg)	Estimated ILCR	Primary Target Organs	Residential Soil RSL[2] (mg/kg)	Estimated HQ
Benzo(a)pyrene Equivalents-1/2 U	0.14	0.015	9.3E-06	NA	NA	NA
		Total ILCR	9E-06		Total HI	NA

1 - The maximum concentration is used in place of the 95% UCL because there are fewer than 5 samples in the dataset.
2 - Source: USEPA, November 2011.

EPC = Exposure Point Concentration
HI = Hazard Index
HQ = Hazard Quotient
ILCR = Incremental Lifetime Carcinogenic Risk
RSL = Regional Screening Level

TABLE G-15

RISK CHARACTERIZATION - TOTAL RISKS - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
Chemical	**EPC: Maximum Concentration(1) (mg/kg)**	**Residential Soil RSL(2) (mg/kg)**	**Estimated ILCR**	**Primary Target Organs**	**Residential Soil RSL(2) (mg/kg)**	**Estimated HQ**
Benzo(a)pyrene Equivalents-1/2 U	0.26	0.015	1.7E-05	NA	NA	NA
Arsenic	0.962	0.39	2.5E-06	Skin, Cardiovascular System	22	0.044
Chromium(3)	2.71	0.29	9.3E-06	Respiratory	230	0.012
Cobalt	2.55	370	6.9E-09	Thyroid	23	0.11
Iron	15200	NA	NA	Gastrointestinal System	55000	0.28
Manganese	437	NA	NA	Central Nervous System	1800	0.24
		Total ILCR	3E-05		**Total HI**	0.5

1 - The maximum concentration is used in place of the 95% UCL because there are fewer than 5 samples in the dataset.
2 - Source: USEPA, November 2011.
3 - Total chromium is conservatively evaluated using criteria for hexavalent chromium.

EPC = Exposure Point Concentration
HI = Hazard Index
HQ = Hazard Quotient
ILCR = Incremental Lifetime Carcinogenic Risk
RSL = Regional Screening Level

TABLE G-16

RISK CHARACTERIZATION - TOTAL RISKS - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
Chemical	**EPC: 95% UCL or Maximum Concentration[1] (mg/kg)**	**Residential Soil RSL[2] (mg/kg)**	**Estimated ILCR**	**Primary Target Organs**	**Residential Soil RSL[2] (mg/kg)**	**Estimated HQ**
Benzo(a)pyrene Equivalents-1/2 U[3][4]	1.34	0.015	8.9E-05	NA	NA	NA
Aluminum	5850	NA	NA	Central Nervous System	77000	0.08
Arsenic	1.77	0.39	4.5E-06	Skin, Cardiovascular System	22	0.08
Chromium[5]	6.8	0.29	2.3E-05	Respiratory	230	0.030
Cobalt	3.75	370	1.0E-08	Thyroid	23	0.16
Iron	11740	NA	NA	Gastrointestinal System	55000	0.21
Manganese	260	NA	NA	Central Nervous System	1800	0.14
		Total ILCR	1E-04		**Total HI**	0.7

1 - The maximum concentration is used in place of the 95% UCL if there are fewer than 5 samples or 3 positive detections in a dataset or if the 95% UCL is greater than the maximum concentration.
2 - Source: USEPA, November 2011.
3 - Benzo(a)pyrene equivalents was selected as a COPC in both the EPH and SVOC fractions; the benzo(a)pyrene equivalents value presented is from the SVOC fraction to be conservative due to the greater EPC.
4 - The maximum concentration was used as the EPC.
5 - Total chromium is conservatively evaluated using criteria for hexavalent chromium.

COPC = Chemical of Potential Concern
EPC = Exposure Point Concentration
EPH = Extractable Petroleum Hydrocarbon
HI = Hazard Index
HQ = Hazard Quotient
ILCR = Incremental Lifetime Carcinogenic Risk
SVOC = Semivolatile Organic Compound
UCL = Upper Confidence Limit

TABLE G-17

COMPARISON OF EPH AND VPH RESULTS TO MCP CRITERIA - APRON AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentrations(4)	MCP S-1/G-1 Standard (mg/kg)(5)	Maximum Concentration Exceeds Criterion?
Apron Excavation Area	**EXTRACTABLE PETROLEUM HYDROCARBONS**											
	--	C11-C22 Aromatics	15500 J	15500 J	UG/KG	C-B82-APN-SW-14	1/15	26500 - 37900	15500	NA	1000000	No
	--	C9-C18 Aliphatics	62400	62400	UG/KG	C-B82-APN-SW-14	1/15	26500 - 37900	62400	NA	1000000	No
	VOLATILE PETROLEUM HYDROCARBONS											
	--	**C5-C8 Aliphatics**	8530	176000	UG/KG	C-B82-APN-SW-14	3/15	2900 - 3850	176000	NA	**100000**	**Yes**
	--	C9-C10 Aromatics	1230	75500	UG/KG	C-B82-APN-SW-14	5/15	580 - 700	75500	NA	100000	No
	--	C9-C12 Aliphatics	2070 J	107000	UG/KG	C-B82-APN-SW-14	5/15	2900 - 3850	107000	NA	1,000,000	No
	100-41-4	Ethylbenzene	97 J	4070	UG/KG	C-B82-APN-SW-14	3/15	120 - 190	4070	NA	40000	No
	--	m+p-Xylenes	1190	2600	UG/KG	C-B82-APN-SW-08	2/15	230 - 310	2600	**4**	400000 (6)	No
	91-20-3	Naphthalene	879	879	UG/KG	C-B82-APN-SW-14	1/15	120 - 190	879	NA	4000	No
	--	o-Xylene	102 J	1200	UG/KG	C-B82-APN-SW-14	3/15	120 - 190	1200	**4**	400000 (6)	No

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
5 - Massachusetts Contingency Plan (MCP) Method 1: Soil Category S-1 Standards. S-1 Soil & GW-1 Groundwater. 310 CMR 40.0000, 12/14/2007.
6 - Values are for xylenes (mixed isomers).

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria.

Definitions:
EPH = Extractable Petroleum Hydrocarbons
J = Estimated value
NA = Not applicable/not available
VPH = Volatile Petroleum Hydrocarbons

Associated Samples:
C-B82-APN-B-01
C-B82-APN-B-02
C-B82-APN-B-03
C-B82-APN-B-04
C-B82-APN-B-04-D
C-B82-APN-SW-05
C-B82-APN-SW-06
C-B82-APN-SW-07
C-B82-APN-SW-08
C-B82-APN-SW-09
C-B82-APN-SW-10
C-B82-APN-SW-11
C-B82-APN-SW-12
C-B82-APN-SW-13
C-B82-APN-SW-14
C-B82-APN-SW-15

TABLE G-18

COMPARISON OF EPH AND VPH RESULTS TO MCP CRITERIA - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SUBSURFACE SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentrations(4)	MCP S-1/G-1 Standard (mg/kg)(5)	Maximum Concentration Exceeds Criterion?
GTM/FDS Area	**EXTRACTABLE PETROLEUM HYDROCARBONS**											
	--	Bap Equivalent-1/2 U	336	577	UG/KG	FDS-6	2/16	264 - 336	577	NA	2000	No
	--	Bap Equivalent-0 U	71.6	561	UG/KG	FDS-6	2/16	264 - 336	561	NA	2000	No
	56-55-3	Benzo(a)anthracene	199 J	271 J	UG/KG	FDS-6	2/16	264 - 336	271	600	7000	No
	50-32-8	Benzo(a)pyrene	343	343	UG/KG	FDS-6	1/16	264 - 336	343	**16**	2000	No
	205-99-2	Benzo(b)fluoranthene	354	441	UG/KG	C-B82-GTM1-B-5	1/16	264 - 336	441	810	7000	No
	191-24-2	Benzo(g,h,i)perylene	161 J	262 J	UG/KG	FDS-6	2/16	264 - 336	262	330	1000000	No
	207-08-9	Benzo(k)fluoranthene	145 J	168 J	UG/KG	C-B82-GTM1-B-5	1/16	264 - 336	168	320	70000	No
	--	C11-C22 Aromatics	82800	113000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	113000	NA	1000000	No
	--	C19-C36 Aliphatics	105000	111000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	111000	NA	3000000	No
	--	C9-C18 Aliphatics	598000	656000	UG/KG	C-B82-GTM1-B-5	1/16	800 - 33600	656000	NA	1000000	No
	218-01-9	Chrysene	303	396	UG/KG	C-B82-GTM1-B-5	2/16	264 - 336	396	710	70000	No
	53-70-3	Dibenzo(a,h)anthracene	149 J	149 J	UG/KG	FDS-6	1/16	264 - 336	149	**1.7**	700	No
	206-44-0	Fluoranthene	198 J	763	UG/KG	FDS-6	2/16	264 - 336	763	1100	1000000	No
	193-39-5	Indeno(1,2,3-cd)pyrene	145 J	412	UG/KG	FDS-6	2/16	264 - 336	412	**390**	7000	No
	85-01-8	Phenanthrene	598	598	UG/KG	FDS-6	1/16	264 - 336	598	**360**	10000	No
	129-00-0	Pyrene	189 J	612	UG/KG	FDS-6	2/16	264 - 336	612	1000	1000000	No
	VOLATILE PETROLEUM HYDROCARBONS											
	--	C9-C10 Aromatics	2250	67500	UG/KG	C-B82-GTM1-B-5	2/17	520 - 740	67500	NA	100000	No
	--	C9-C12 Aliphatics	3640	92700	UG/KG	C-B82-GTM1-B-5	2/17	2600 - 3700	92700	NA	1000000	No
	91-20-3	Naphthalene	393	488	UG/KG	C-B82-GTM1-B-5	2/17	100 - 150	488	NA	4000	No

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
5 - Massachusetts Contingency Plan (MCP) Method 1: Soil Category S-1 Standards. S-1 Soil & GW-1 Groundwater. 310 CMR 40.0000, 12/14/2007.

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria.

Definitions:
CAS = Chemical Abstract Service
EPH = Extractable Petroleum Hydrocarbons
J = Estimated value
NA = Not applicable/not available
VPH = Volatile Petroleum Hydrocarbons

Associated Samples:

B82-SO-106-0608	C-B82-GTM-2-SW-02	C-B82-GTM3-SW-04-D	FDS 4-4
B82-SO-109-0608	C-B82-GTM-2-SW-02-D	C-B82-GTM4-B-5	FDS-5
C-B82-GTM1-B-5	C-B82-GTM-2-SW-03	C-B82-GTM4-SW-01	FDS-6
C-B82-GTM1-B-5-D	C-B82-GTM-2-SW-04	C-B82-GTM4-SW-02	
C-B82-GTM1-SW-01	C-B82-GTM-2-SW-04-D	C-B82-GTM4-SW-03	
C-B82-GTM1-SW-02	C-B82-GTM3-B-5	C-B82-GTM4-SW-4	
C-B82-GTM1-SW-03	C-B82-GTM3-SW-01	FDS 4-1	
C-B82-GTM1-SW-04	C-B82-GTM3-SW-02	FDS 4-2	
C-B82-GTM-2-B-5	C-B82-GTM3-SW-03	FDS 4-3	
C-B82-GTM-2-SW-01	C-B82-GTM3-SW-04	FDS 4-3-D	

TABLE G-19

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SATURATED SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Saturated Soil
Exposure Medium: Saturated Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
GTM/FDS Area	**METALS**												
	7429-90-5	Aluminum	4450	9080 J	MG/KG	B82-SO-107-1012	13/13	-	9080	8520	7700 N	Yes	ASL
	7440-38-2	Arsenic	0.509	1.51	MG/KG	B82-SO-111-1214-D	13/13	-	1.51	1.89	0.39 C	No	BKG
	7440-39-3	Barium	12.9	25.8 J	MG/KG	B82-SO-107-1012	12/13	14.1 - 14.1	25.8	27.0	1500 N	No	BSL, BKG
	7440-41-7	Beryllium	0.133 J	0.497 J	MG/KG	B82-SO-112-1416	13/13	-	0.497	0.44	16 N	No	BSL
	7440-43-9	Cadmium	0.16	0.465	MG/KG	B82-SO-109-0810	13/13	-	0.465	0.12	7 N	No	BSL
	7440-70-2	Calcium	631 J	7550 J	MG/KG	B82-SO-112-1214	13/13	-	7550	1550	NA	No	NUT
	18540-29-9	Chromium	3.41 J	9.18 J	MG/KG	B82-SO-113-1214	13/13	-	9.18	10.2	0.29 C[7]	No	BKG
	7440-48-4	Cobalt	1.84 J	7.98 J	MG/KG	B82-SO-107-1012	13/13	-	7.98	4.7	2.3 N	Yes	ASL
	7440-50-8	Copper	3.15	13.4 J	MG/KG	B82-SO-107-1012	13/13	-	13.4	14.2	310 N	No	BSL, BKG
	57-12-5	Cyanide	0.1 J	0.23 J	MG/KG	B82-SO-111-1214-D	8/13	0.19 - 0.25	0.23	0.22	160 N	No	BSL
	7439-89-6	Iron	8110	19300	MG/KG	B82-SO-107-1012	13/13	-	19300	11450	5500 N	Yes	ASL
	7439-92-1	Lead	2.45 J	6.07 J	MG/KG	B82-SO-108-0810	13/13	-	6.07	9.3	400	No	BSL, BKG
	7439-95-4	Magnesium	706 J	3760 J	MG/KG	B82-SO-112-1214	13/13	-	3760	2250	NA	No	NUT
	7439-96-5	Manganese	125	361 J	MG/KG	B82-SO-107-1012	13/13	-	361	414	180 N	No	BKG
	7439-97-6	Mercury	0.0104 J	0.0104 J	MG/KG	B82-SO-108-1012	1/13	0.0056 - 0.00692	0.0104	0.11	2.3 N[8]	No	BSL, BKG
	7440-02-0	Nickel	3.58 J	12.8	MG/KG	B82-SO-107-1012	13/13	-	12.8	6.5	150 N	No	BSL
	7440-09-7	Potassium	176 J	219 J	MG/KG	B82-SO-107-0810	7/13	335 - 471	219	457	NA	No	NUT, BKG
	7782-49-2	Selenium	0.0425 J	0.332	MG/KG	B82-SO-108-1012-D	10/13	0.23 - 0.334	0.332	0.41	39 N	No	BSL, BKG
	7440-22-4	Silver	0.0603 J	0.0947 J	MG/KG	B82-SO-109-0810	7/13	0.0241 - 0.0389	0.0947	0.28	39 N	No	BSL, BKG
	7440-23-5	Sodium	28.9 J	59.4 J	MG/KG	B82-SO-109-0810	3/13	30 - 101	59.4	144	NA	No	NUT, BKG
	7440-28-0	Thallium	0.0131 J	0.0314	MG/KG	B82-SO-111-1214-D	7/13	0.0148 - 0.0267	0.0314	0.22	0.078 N	No	BSL, BKG
	7440-62-2	Vanadium	8.69 J	26.9	MG/KG	B82-SO-107-1012	13/13	-	26.9	17.1	39 N	No	BSL
	7440-66-6	Zinc	18.3	66.3	MG/KG	B82-SO-107-1012	13/13	-	66.3	28.7	2300 N	No	BSL
	PESTICIDES/PCBS												
	72-54-8	4,4'-DDD	2.8	5.4 J	UG/KG	B82-SO-108-1012-D	2/13	1.7 - 2.1	5.4	4.2	2000 C	No	BSL
	50-29-3	4,4'-DDT	2.3	2.3	UG/KG	B82-SO-113-1214	1/13	1.7 - 2.1	2.3	4.6	1700 C	No	BSL, BKG
	5103-74-2	gamma-Chlordane	1.2 J	1.2 J	UG/KG	B82-SO-108-1012-D	1/13	0.89 - 1.1	1.2	NA	1600 C[9]	No	BSL
	1024-57-3	Heptachlor Epoxide	1.1 J	1.1 J	UG/KG	B82-SO-113-1214	1/13	0.89 - 1.1	1.1	NA	53 C	No	BSL
	SEMIVOLATILES												
	91-57-6	2-Methylnaphthalene	9.4	100	UG/KG	B82-SO-108-1012	2/13	3.4 - 4.2	100	NA	31000 N	No	BSL
	83-32-9	Acenaphthene	4.5	100 J	UG/KG	B82-SO-109-0810	4/13	3.4 - 3.9	100	NA	340000 N	No	BSL
	208-96-8	Acenaphthylene	4.1	15 J	UG/KG	B82-SO-108-1012	3/13	3.4 - 4.2	15	NA	340000 N[10]	No	BSL
	120-12-7	Anthracene	4.2	81 J	UG/KG	B82-SO-109-0810	5/13	3.5 - 3.9	81	NA	1700000 N	No	BSL
	--	Bap Equivalent-1/2 U	4.6	385	UG/KG	B82-SO-109-0810	7/13	3.5 - 3.9	385	NA	15 C	Yes	ASL
	--	Bap Equivalent-0 U	0.92	309 J	UG/KG	B82-SO-108-1012	7/13	3.5 - 3.9	309	NA	15 C	Yes	ASL
	56-55-3	Benzo(a)anthracene	3.9	230	UG/KG	B82-SO-108-1012	7/13	3.5 - 3.9	230	600	150 C	No	BKG
	50-32-8	Benzo(a)pyrene	6	200	UG/KG	B82-SO-108-1012	6/13	3.5 - 3.9	200	16	15 C	Yes	ASL
	205-99-2	Benzo(b)fluoranthene	5.3	310 J	UG/KG	B82-SO-108-1012	7/13	3.5 - 3.9	310	810	150 C	No	BKG
	191-24-2	Benzo(g,h,i)perylene	4.2	140 J	UG/KG	B82-SO-108-1012	6/13	3.5 - 3.9	140	330	170000 N[11]	No	BSL, BKG
	207-08-9	Benzo(k)fluoranthene	4.9	94	UG/KG	B82-SO-108-1012	5/13	3.5 - 3.9	94	320	1500 C	No	BSL, BKG
	117-81-7	Bis(2-ethylhexyl)phthalate	81 J	150 J	UG/KG	B82-SO-107-1012	5/13	340 - 610	150	205	35000 C	No	BSL, BKG

TABLE G-19

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SATURATED SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Scenario Timeframe: Current/Future
Medium: Saturated Soil
Exposure Medium: Saturated Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
GTM/FDS Area		**SEMIVOLATILES (continued)**											
	218-01-9	Chrysene	3.7	240	UG/KG	B82-SO-108-1012	7/13	3.5 - 3.9	240	710	15000 C	No	BSL, BKG
	53-70-3	**Dibenzo(a,h)anthracene**	10	41	UG/KG	B82-SO-108-1012	2/13	3.4 - 420	41	**1.7**	**15 C**	**Yes**	ASL
	206-44-0	Fluoranthene	4.1	460 J	UG/KG	B82-SO-108-1012	10/13	3.5 - 3.9	460	1100	230000 N	No	BSL, BKG
	86-73-7	Fluorene	5.6	56 J	UG/KG	B82-SO-109-0810	4/13	3.4 - 3.9	56	NA	230000 N	No	BSL
	91-20-3	Naphthalene	8.1	62	UG/KG	B82-SO-108-1012	2/13	3 - 3.9	62	NA	3600 C	No	BSL
	85-01-8	Phenanthrene	3.7	340	UG/KG	B82-SO-108-1012	9/13	3.5 - 3.9	340	360	170000 N[11]	No	BSL, BKG
	108-95-2	Phenol	5.4	5.6	UG/KG	B82-SO-111-1214	1/13	3.4 - 4.2	5.6	NA	1800000 N	No	BSL
	129-00-0	Pyrene	3.7	330 J	UG/KG	B82-SO-108-1012	10/13	3.5 - 3.9	330	1000	170000 N	No	BSL, BKG
		VOLATILES											
	75-34-3	1,1-Dichloroethane	1 J	5	UG/KG	B82-SO-111-1214	2/13	3 - 4	5	NA	3300 C	No	BSL
	95-63-6	1,2,4-Trimethylbenzene	3 J	3 J	UG/KG	B82-SO-108-1012	1/13	3 - 4	3	NA	6200 N	No	BSL
	78-93-3	2-Butanone	7 J	14 J	UG/KG	B82-SO-111-1214	2/13	3 - 4	14	**9.5**	2800000 N	No	BSL
	67-64-1	Acetone	4	40	UG/KG	B82-SO-108-1012	2/13	3 - 44	40	59.8	6100000 N	No	BSL, BKG
	75-15-0	Carbon Disulfide	1 J	1 J	UG/KG	B82-SO-108-1012	1/13	3 - 4	1	NA	82000 N	No	BSL
	75-00-3	Chloroethane	4	4	UG/KG	B82-SO-111-1214	1/13	3 - 4	4	NA	1500000 N	No	BSL
	156-59-2	cis-1,2-Dichloroethene	39	39	UG/KG	B82-SO-112-1214	1/13	3 - 4	39	NA	16000 N	No	BSL
	98-82-8	Isopropylbenzene	1 J	11 J	UG/KG	B82-SO-108-1012	1/13	3 - 4	11	NA	210000 N	No	BSL
	75-09-2	Methylene Chloride	1 J	3 J	UG/KG	B82-SO-108-0810	4/13	3 - 9	3	NA	11000 C	No	BSL
	104-51-8	N-Butylbenzene	4	4	UG/KG	B82-SO-108-1012	1/13	3 - 4	4	NA	390000 N	No	BSL
	103-65-1	N-Propylbenzene	10 J	10 J	UG/KG	B82-SO-108-1012	1/13	3 - 4	10	NA	340000 N	No	BSL
	135-98-8	sec-Butylbenzene	1 J	9	UG/KG	B82-SO-108-1012	3/13	3 - 4	9	NA	NA	No	NTX
	127-18-4	**Tetrachloroethene**	1 J	1100 J	UG/KG	B82-SO-112-1214	2/13	3 - 4	1100	**6**	**550 C**	**Yes**	ASL
	540-59-0	Total 1,2-Dichloroethene	40	40	UG/KG	B82-SO-112-1214	1/13	3 - 4	40	NA	70 N[12]	No	BSL
	156-60-5	trans-1,2-Dichloroethene	1 J	1 J	UG/KG	B82-SO-112-1214	1/13	3 - 4	1	NA	15000 N	No	BSL
	79-01-6	Trichloroethene	14	14	UG/KG	B82-SO-112-1214	1/13	0.5 - 0.8	14	NA	440 N[13]	No	BSL

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Source: Supplement to Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone and Webster, November 2002).
5 - USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, November 2011. [Cancer benchmark value = 1E-06, hazard quotient (HQ) = 0.1].
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and is greater than background.
7 - The value is for hexavalent chromium.
8 - The value is for mercuric chloride (and other mercury salts).
9 - The value is for chlordane.
10 - The value for acenaphthene is used as a surrogate for acenaphthylene.
11 - The value for pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
12 - The value is for 1,2-dichloroethene (mixed isomers).
13 - One-tenth the noncarcinogenic level is less than the carcinogenic level; therefore, the noncarcinogenic level is presented.

Definitions:
C = Carcinogen
CAS = Chemical Abstract Service
COPC = Chemical of potential concern
J = Estimated value
N = Noncarcinogen
NA = Not applicable/not available

Rationale Codes:
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BKG = Less than background concentration
BSL = Below screening level
NTX = No toxicity criteria

TABLE G-19

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GAS TRAP MANHOLE/FLOOR DRAIN SYSTEM AREA SATURATED SOIL
BUILDING 82 RISK RATIO EVALUATION
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

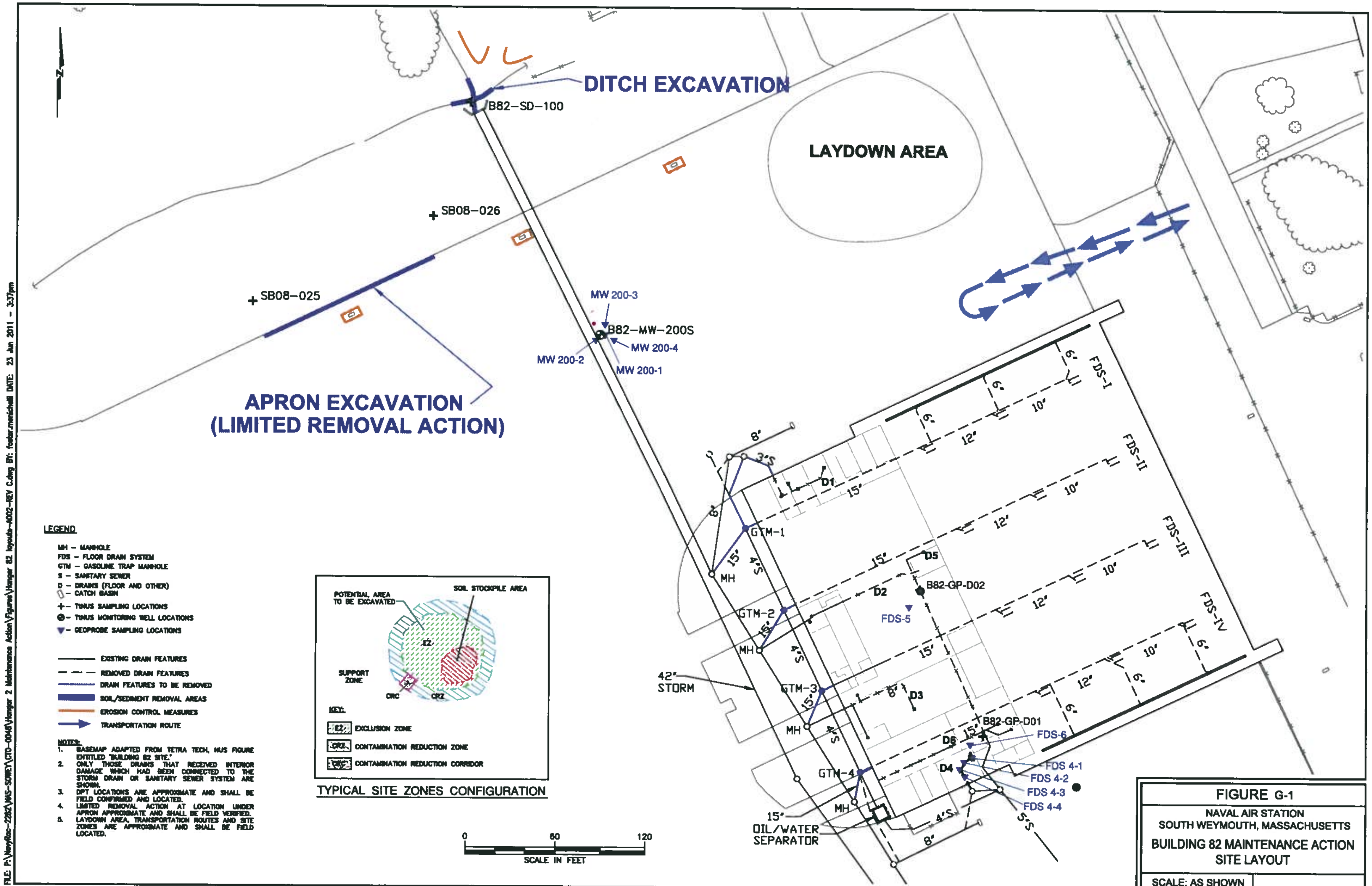
Scenario Timeframe: Current/Future
Medium: Saturated Soil
Exposure Medium: Saturated Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentration[4]	Adjusted USEPA RSL - Residential Soil[5]	COPC Flag	Rationale for Contaminant Deletion or Selection[6]

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples:
B82-SO-106-0810
B82-SO-107-0810
B82-SO-107-1012
B82-SO-108-0810
B82-SO-108-1012
B82-SO-108-1012-D
B82-SO-109-0810
B82-SO-110-1214
B82-SO-111-1214
B82-SO-111-1214-D
B82-SO-111-1416
B82-SO-112-1214
B82-SO-112-1416
B82-SO-113-1214
B82-SO-113-2830

FIGURES



CAD FILE: HANGER 82 LAYOUTS-A002-REV C.DWG

PROUCL OUTPUT

	General UCL Statistics for Full Data Sets		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

Aluminum

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	10
Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	3100	Minimum of Log Data	8.039
Maximum	7430	Maximum of Log Data	8.913
Mean	5232	Mean of log Data	8.535
Median	5300	SD of log Data	0.25
SD	1250		
Std. Error of Mean	346.7		
Coefficient of Variation	0.239		
Skewness	0.185		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Test Statistic	0.918
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	5850	95% H-UCL	6008
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6831
95% Adjusted-CLT UCL (Chen-1995)	5822	97.5% Chebyshev (MVUE) UCL	7521
95% Modified-t UCL (Johnson-1978)	5853	99% Chebyshev (MVUE) UCL	8875
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	14.04	**Data appear Normal at 5% Significance Level**	
Theta Star	372.7		
MLE of Mean	5232		
MLE of Standard Deviation	1396		
nu star	365		
Approximate Chi Square Value (.05)	321.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	5803
Adjusted Chi Square Value	315.9	95% Jackknife UCL	5850
		95% Standard Bootstrap UCL	5773
Anderson-Darling Test Statistic	0.505	95% Bootstrap-t UCL	5889
Anderson-Darling 5% Critical Value	0.733	95% Hall's Bootstrap UCL	6049
Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL	5772
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL	5784
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6744

		97.5% Chebyshev(Mean, Sd) UCL	7398
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8682
95% Approximate Gamma UCL	5936		
95% Adjusted Gamma UCL	6045		
Potential UCL to Use		Use 95% Student's-t UCL	5850

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12
Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	3	Minimum of Log Data	1.099
Maximum	8.85	Maximum of Log Data	2.18
Mean	5.868	Mean of log Data	1.718
Median	6.3	SD of log Data	0.349
SD	1.834		
Std. Error of Mean	0.509		
Coefficient of Variation	0.313		
Skewness	-0.233		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.95	Shapiro Wilk Test Statistic	0.907
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.775	95% H-UCL	7.209
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8.412
95% Adjusted-CLT UCL (Chen-1995)	6.67	97.5% Chebyshev (MVUE) UCL	9.502
95% Modified-t UCL (Johnson-1978)	6.77	99% Chebyshev (MVUE) UCL	11.64
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.572	**Data appear Normal at 5% Significance Level**	
Theta Star	0.775		
MLE of Mean	5.868		
MLE of Standard Deviation	2.133		
nu star	196.9		
Approximate Chi Square Value (.05)	165.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	6.705
Adjusted Chi Square Value	161.3	95% Jackknife UCL	6.775
		95% Standard Bootstrap UCL	6.673
Anderson-Darling Test Statistic	0.469	95% Bootstrap-t UCL	6.767

Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL	6.653
Kolmogorov-Smirnov Test Statistic	0.168	95% Percentile Bootstrap UCL	6.653
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL	6.638
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.086
		97.5% Chebyshev(Mean, Sd) UCL	9.045
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.93
95% Approximate Gamma UCL	6.985		
95% Adjusted Gamma UCL	7.163		
Potential UCL to Use		Use 95% Student's-t UCL	6.775

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Cobalt

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12
Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.8	Minimum of Log Data	0.588
Maximum	5.31	Maximum of Log Data	1.67
Mean	3.235	Mean of log Data	1.125
Median	3.1	SD of log Data	0.328
SD	1.051		
Std. Error of Mean	0.292		
Coefficient of Variation	0.325		
Skewness	0.56		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.952	Shapiro Wilk Test Statistic	0.969
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.755	95% H-UCL	3.903
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.534
95% Adjusted-CLT UCL (Chen-1995)	3.763	97.5% Chebyshev (MVUE) UCL	5.095
95% Modified-t UCL (Johnson-1978)	3.763	99% Chebyshev (MVUE) UCL	6.197
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	8.045	**Data appear Normal at 5% Significance Level**	

Theta Star	0.402		
MLE of Mean	3.235		
MLE of Standard Deviation	1.141		
nu star	209.2		
Approximate Chi Square Value (.05)	176.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	3.715
Adjusted Chi Square Value	172.4	95% Jackknife UCL	3.755
		95% Standard Bootstrap UCL	3.697
Anderson-Darling Test Statistic	0.205	95% Bootstrap-t UCL	3.813
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL	3.849
Kolmogorov-Smirnov Test Statistic	0.114	95% Percentile Bootstrap UCL	3.679
Kolmogorov-Smirnov 5% Critical Value	0.237	95% BCA Bootstrap UCL	3.732
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	4.506
		97.5% Chebyshev(Mean, Sd) UCL	5.056
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	6.136
95% Approximate Gamma UCL	3.83		
95% Adjusted Gamma UCL	3.924		
Potential UCL to Use		Use 95% Student's-t UCL	3.755

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	11
Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	5700	Minimum of Log Data	8.648
Maximum	18200	Maximum of Log Data	9.809
Mean	10192	Mean of log Data	9.195
Median	9700	SD of log Data	0.27
SD	2953		
Std. Error of Mean	819		
Coefficient of Variation	0.29		
Skewness	1.568		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.864	Shapiro Wilk Test Statistic	0.943
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11652	95% H-UCL	11824
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13529
95% Adjusted-CLT UCL (Chen-1995)	11920	97.5% Chebyshev (MVUE) UCL	14977

95% Modified-t UCL (Johnson-1978)	11711	99% Chebyshev (MVUE) UCL	17823
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	11.28	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	903.2		
MLE of Mean	10192		
MLE of Standard Deviation	3034		
nu star	293.4		
Approximate Chi Square Value (.05)	254.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	11540
Adjusted Chi Square Value	249.6	95% Jackknife UCL	11652
		95% Standard Bootstrap UCL	11465
Anderson-Darling Test Statistic	0.445	95% Bootstrap-t UCL	12286
Anderson-Darling 5% Critical Value	0.734	95% Hall's Bootstrap UCL	19027
Kolmogorov-Smirnov Test Statistic	0.157	95% Percentile Bootstrap UCL	11508
Kolmogorov-Smirnov 5% Critical Value	0.236	95% BCA Bootstrap UCL	11831
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	13762
		97.5% Chebyshev(Mean, Sd) UCL	15307
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18342
95% Approximate Gamma UCL	11740		
95% Adjusted Gamma UCL	11981		
Potential UCL to Use		Use 95% Approximate Gamma UCL	11740

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	12
Number of Missing Values	16		
Raw Statistics		**Log-transformed Statistics**	
Minimum	2.5	Minimum of Log Data	0.916
Maximum	631	Maximum of Log Data	6.447
Mean	53.85	Mean of log Data	2.033
Median	5.6	SD of log Data	1.389
SD	173.4		
Std. Error of Mean	48.1		
Coefficient of Variation	3.221		
Skewness	3.604		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.323	Shapiro Wilk Test Statistic	0.599
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	

ProUCL Output - Gas Trap Manhole/Floor Drain System Area Subsurface Soil

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	139.6	95% H-UCL	83.68
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	50.62
95% Adjusted-CLT UCL (Chen-1995)	184.3	97.5% Chebyshev (MVUE) UCL	64.87
95% Modified-t UCL (Johnson-1978)	147.6	99% Chebyshev (MVUE) UCL	92.85
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.317	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	170		
MLE of Mean	53.85		
MLE of Standard Deviation	95.69		
nu star	8.234		
Approximate Chi Square Value (.05)	2.871	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	133
Adjusted Chi Square Value	2.439	95% Jackknife UCL	139.6
		95% Standard Bootstrap UCL	130.4
Anderson-Darling Test Statistic	3.497	95% Bootstrap-t UCL	5155
Anderson-Darling 5% Critical Value	0.821	95% Hall's Bootstrap UCL	2044
Kolmogorov-Smirnov Test Statistic	0.469	95% Percentile Bootstrap UCL	149.9
Kolmogorov-Smirnov 5% Critical Value	0.255	95% BCA Bootstrap UCL	197.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	263.5
		97.5% Chebyshev(Mean, Sd) UCL	354.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	532.4
95% Approximate Gamma UCL	154.4		
95% Adjusted Gamma UCL	181.8		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	263.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

Arsenic

General Statistics			
Number of Valid Data	13	Number of Detected Data	12
Number of Distinct Detected Data	10	Number of Non-Detect Data	1
Number of Missing Values	16	Percent Non-Detects	7.69%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.89	Minimum Detected	-0.117
Maximum Detected	2.75	Maximum Detected	1.012
Mean of Detected	1.554	Mean of Detected	0.396
SD of Detected	0.522	SD of Detected	0.305
Minimum Non-Detect	0.71	Minimum Non-Detect	-0.342
Maximum Non-Detect	0.71	Maximum Non-Detect	-0.342

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.833	Shapiro Wilk Test Statistic	0.917
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.462	Mean	0.286
SD	0.601	SD	0.493
95% DL/2 (t) UCL	1.759	95% H-Stat (DL/2) UCL	2.026
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.469	Mean in Log Scale	0.341
SD	0.567	SD in Log Scale	0.353
95% MLE (t) UCL	1.749	Mean in Original Scale	1.49
95% MLE (Tiku) UCL	1.75	SD in Original Scale	0.55
		95% t UCL	1.762
		95% Percentile Bootstrap UCL	1.742
		95% BCA Bootstrap UCL	1.773
		95% H UCL	1.827
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	8.522	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	0.182		
nu star	204.5		

A-D Test Statistic	0.683	**Nonparametric Statistics**	
5% A-D Critical Value	0.731	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.731	Mean	1.503
5% K-S Critical Value	0.245	SD	0.512
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.148
		95% KM (t) UCL	1.767
Assuming Gamma Distribution		95% KM (z) UCL	1.747
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.762
Minimum	0.111	95% KM (bootstrap t) UCL	2.001
Maximum	2.75	95% KM (BCA) UCL	1.772
Mean	1.443	95% KM (Percentile Bootstrap) UCL	1.756
Median	1.4	95% KM (Chebyshev) UCL	2.15
SD	0.641	97.5% KM (Chebyshev) UCL	2.429
k star	2.426	99% KM (Chebyshev) UCL	2.979
Theta star	0.595		
Nu star	63.08	**Potential UCLs to Use**	
AppChi2	45.81	95% KM (BCA) UCL	1.772
95% Gamma Approximate UCL	1.987		
95% Adjusted Gamma UCL	2.082		
Note: DL/2 is not a recommended method.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.